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ABSTRACT

These units of instructional materials and teaching aids are the final four of a series of 10 designed for use in metropolitan agriculture/horticulture programs for students in grades 9 and 10. Covered in the unit on growing and managing horticultural crops are watering plants; pruning, pinching, and planting plants; using plant production equipment; understanding and controlling light and temperature around plants; and growing vegetables. Identifying and controlling horticultural plant pests and the safe use of pesticides are examined. Discussed next are the care and feeding of the family dog, cat, and horse. Pasteurizing and preparing a growing media for the greenhouse; collecting soil samples from the greenhouse, garden, and lawn and applying test results; and identifying soil amendments and their functions are described in the unit on soil science and conservation of natural resources. Each of these units or problem area packets includes some or all of the following components: suggestions to the teacher, a content outline, a teacher's guide, information sheets, student worksheets or assignment sheets and keys, demonstrations, job sheets, transparencies, a discussion guide for the transparencies, and sample test questions and a teacher's key. (The remaining six units are available separately--see note.) (MN)

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Core I Materials for Metropolitan Agriculture/Horticulture Programs

Illinois
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Adult
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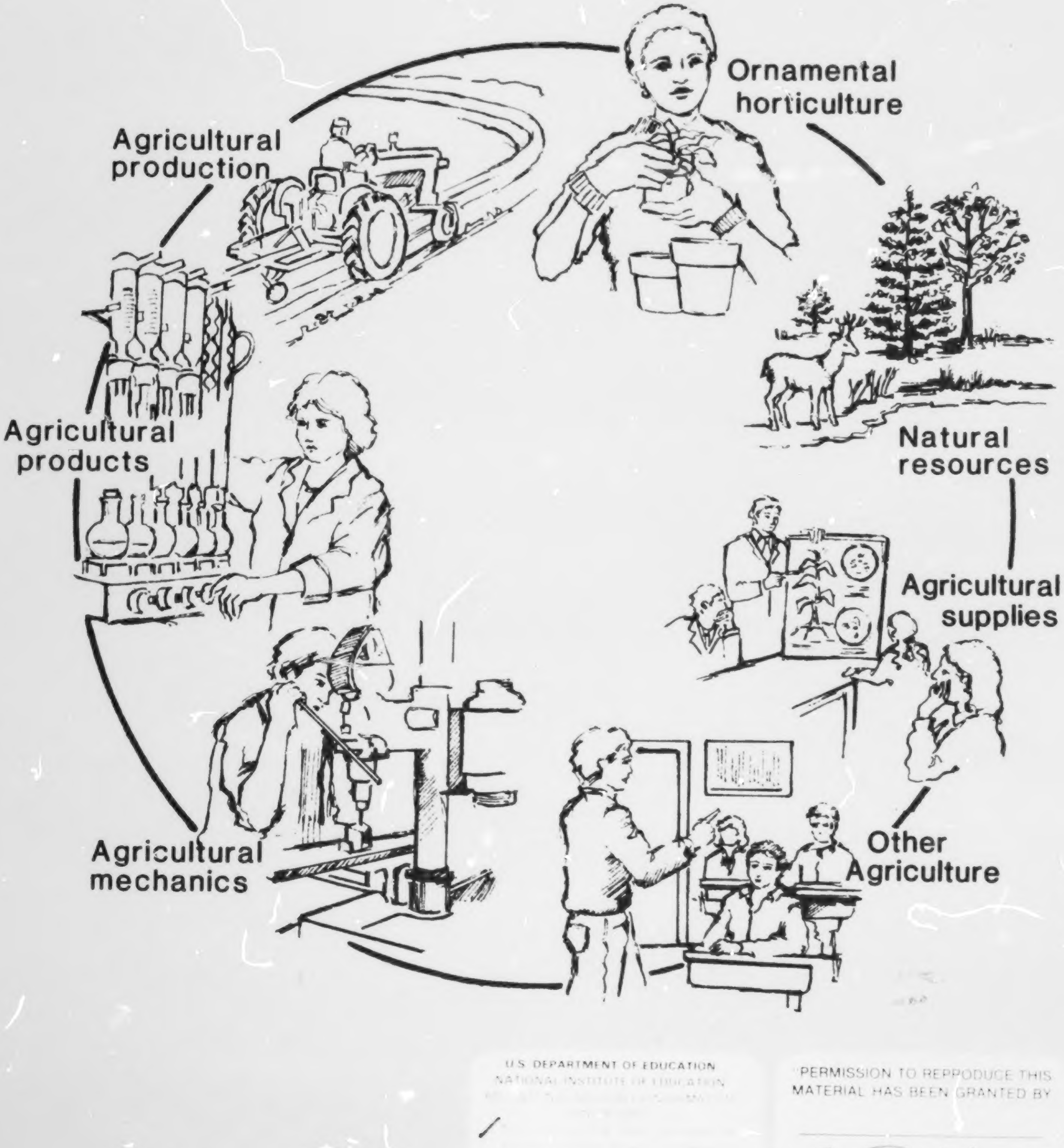
ED208153

CE 030 182


Ornamental horticulture
Agricultural production
Natural resources
Agricultural products
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Agricultural mechanics
Other Agriculture

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UNIT G: Growing and Managing Horticultural Crops

PROBLEM AREAS:

1. Watering plants
2. Pruning, pinching and disbudding plants
3. Planting plants
4. Identifying and using structures used in the production of plants
5. Understanding and controlling temperature around plants
6. Understanding and controlling light around plants
7. Growing vegetables

HORT. CROPS

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: WATERING PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area should be taught to freshman or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the spring and fall semesters. The fall semester materials could emphasize the watering of turf, trees and shrubs as well as effects of water in propagation. Spring watering materials should emphasize the watering of indoor plants and bedding plants.

The estimated instructional time for this problem area is 5 to 10 days, depending on how far the teacher wishes to go in developing watering skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instructional can be 4 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this are for reference and modification as instructors adapt this material to their local situation.

CREDIT SOURCES:

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The teacher's guide, laboratory exercises, and test questions were developed by Jim Ethridge. Transparency masters and the transparency discussion guide were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers. The student worksheet on "Watering a Lawn" was adapted from a horticulture task sheet prepared by the Department of Agricultural Education, The Pennsylvania State University.

TEACHER'S GUIDE

I. Unit: Growing and managing horticultural crops

II. Problem area: Watering plants

III. Objectives: At the close of this problem area students will be able to:

1. Identify watering equipment.
2. Use watering equiplment.
3. Demonstrate ability in watering landscape, nursery, turf, greenhouse crop and various house plants in various environmental conditions.
4. Identify factors which influence the amount of water to apply to plants.

IV. Suggested interest approaches:

1. Using the demonstration method of teaching will be very valuable in this problem area. Demonstrations could illustrate the following practices or situations:
    a. Overwatering
    b. Underwatering
    c. Wilting point
    d. Moisture stress
    e. Permanent wilting point
    f. Containers
    g. Comparison of same plants in different containers with same amount of water
    h. Comparison of same plants in different soils with same container and same amounts of soils
    i. Multiple flush (vs) single flush plants
    j. Deep watering of plants
    k. Dry a soil
    l. Collect a water logged soil
2. Show slides or collect a variety of watering systems, use catalogs showing alternatives.

3. Show how different watering levels affect plants growing in different media.

4. Grow two plants with equal factors except the amount of moisture.

5. Cover a plant in a bell jar and observe the transpiration of water.

V. Anticipated problems and concerns of students:

1. What types of watering equipment are available for what purposes?

2. How does one determine if they are under watering or overwatering?

3. How often should I water?

4. How do I perform maintenance required for various types of watering equipment?

5. How do I determine the amount of water to apply?

6. What is the water capacity of a soil?

7. What is the wilting point of a plant?

8. How do plants lose water?

9. What is the function of water in the soil and plant?

10. What are the different types of mist nozzles?

11. What is a breaker? Why are they used?

12. How do you determine the need for watering?

13. How does automatic watering work? Beds? Pots?

14. How much water can be found in the plant body?

15. How much water is used by the plant?

16. What type of damage can be caused by overwatering plants?

17. What are the symptoms of an overwatered and underwatered plant?

VI. Suggested learning activities and experiences:

1. Display plants that have been overwatered, underwatered.

2. Have students read suggested references and record tentative answers to the problems and concerns identified by the class or teacher.

3. Set up demonstrations showing effects to too much and too little water.

4. Have the student assigned a group of plants to water, in the greenhouse, landscape or "on farm" in the classrooms and offices.

5. Have students perform laboratory exercises included with this problem area.

VII. Application procedures:

1. The main purposes of this problem area are to teach information and develop watering techniques.

2. The application phase should be emphasized in the land laboratory, school greenhouse, on-the-job experience and in or around the students' home when watering plants.

VIII. Evaluation:

1. Prepare and administer a pencil paper objective using Sample Test Questions.

2. Collect and grade laboratory exercises.

3. Observe performance of students during routine watering experiences:

    a. Plants were watered only when necessary

    b. Water was applied at rate of absorption by soil

    c. Moisture level of soil around plants was adequate

    d. Plants were watered usually in early morning.

References and aids:

1. The Greenhous Environment, The Effect of Environmental Factors on Flower Crops, by John Mastalerz, John Wiley and Sons, New York, Read Chapter 7 "Watering" pp. 426 to 445.

2. 50 Laboratory Exercises for Vocational Ornamental Horticulture, Compiled by Paul Hemp, The Interstate Printers and Publishers, Danville, Illinois.

    A. "Effects of Different Watering Intervals on Plants Growing in Different Media" pp. 97 to 100.

   B. "Rate of Transpiration" pp. 101 and 102.

3. Laboratory Exercises on:

   A. "Greenhouse Watering"

   B. "Watering a Lawn"

   C. "Watering Recently Planted Trees and Shrubs"

   D. "Transpiration"

   E. "Watering Plants in the Home"

4. Transparencies and Transparency Discussion Guide

5. Sample Tests Questions

6. Vocational Agriculture Service Units:

   A. # 5003 "Fertilizing and Watering Shade and Ornamental Trees" p. 9 & 10.

   B. # 5019 "Care of Flowering Pot Plants in the Home" p. 1 & 2.

   C. # 5007 "Growing Plants Indoors" p. 5 to 8.

7. University of Illinois, Cooperative Extension Service, Horticulture Facts.

   A. FL 8 79 "Characteristics of Water"

   B. FL 11 80 "Water and Plant Growth"

   C. FL 7 79 "Water Retention of Transplanted Container Soils"

   D. FL 12 80 "Planting and Maintaining a Terrarium"

   E. FL 1 79 "Indoor Gardening"

LABORATORY EXERCISE

GREENHOUSE WATERING

I. Objectives:

1. To develop an understanding of the different kinds of equipment that can be used for watering greenhouse crops.

2. To develop an understanding of watering practices that can be used for different greenhouse crops.

3. To develop the ability to select and use suitable equipment and desirable methods of watering for different growing situations.

II. Materials:

1. Hose.

2. Breakers, such as rose-shaped, winged, bell-shaped, Ravine-type or adjustable nozzles. Try to have as many as possible and have an adjustable nozzle in addition to the other breakers available. If breakers cannot be purchased, they may be constructed quite easily. Plan and design them following the pictures and diagrams in this problem area and other sources.

3. Bench planted and potted plants of sizes varying from seedlings to mature specimens.

III. Procedures:

1. Let each student select a container of seedlings as well as cut flowers and potted plants. Each student should have the opportunity to work with different size plants in this demonstration, but if there are not enough plants for individual work, small groups of students may work with fewer plants.

2. Water each of the containers of plants or benches of plants, using different methods in each case. For example, one student may use fog watering for seedlings, while another may use this method for slightly larger plants. One student may use a "rose" breaker for watering seedlings and another may use the same method for watering mature plants. Devise as many combinations as possible, using the different types of plants and equipment. Use the following instructions for each method:

Fog nozzle. This type of breaker is used to produce a fine mist of spray over the plants. A regular fog nozzle or an adjustable garden nozzle may be used. Direct the fog over the plants so that the mist will fall on the plants and the planting medium.

Other Mechanical Breakers. Water breakers are used for various greenhouse watering operations. Reasons for using breakers include: (1) preventing soil compaction; (2) watering small seedlings to keep them from falling over or being damaged: (3) preventing soil disturbance. Breakers are designed so that the opening is larger than the hose, thus, reducing pressure. In addition to this design, they sometimes have baffles built in to break the flow of the water. A third design feature is shape and special heads, both of which break the force of the water. The Ravine breaker is "L" shaped and has a tube near the hose end, through which air is drawn as the water passes it. This mixture of air and water, when emitted, provides a large volume of water with practically no pressure.

Divide the plants into groups according to size. Water each group of plants, using different breakers so the effects can be studied. Water all of the different sizes of plants with as many breakers as are available. Control the breaker with the right hand (for right-handed persons) and control the hose with the left. Apply the water as near the soil as possible and between the rows or between the individual plants.

Apply water at the rate of about one gallon per square foot of soil, six inches deep. Use common sense when using the different devices. For example, a breaker such as the Ravine which applies a large volume of water, should not be used for watering seedlings.

Hand Breaking. When using a hose without a mechanical breaker, hold the end of the hose in the right hand (for right-handed persons) and guide it with the left hand by holding it approximately 18 to 24 inches behind the end. Break the force of the water with the thumb or the fingers. Do not regulate the flow so that it increases the pressure rather than breaking the force of the water. Apply the water as close to the soil as possible and between the rows of plants.

3. The time to water potted plants may be determined by observing the color of the soil. Dry soil takes on a lighter color. Also, dry soil will shrink away from the sides of the pots. The touch method may be used to determine dryness. By touching the soil with the thumb or the fingers, the moisture can be felt. A method that is commonly used by experienced growers is to strike the side of the pot with the end of the hose and listen for a characteristic ring which indicates a need for water.

4. In benches containing an appropriate drainage system, that is, a layer of drainage material in the bottom of the bench and a way for the water to leave the bench, the soil should be watered in such a manner that the entire soil volume will be moistened. This condition can be determined by making sure that a certain amount of water will flow from the end of the bottom of the bench. If this method is used, care must be taken to avoid excessive leaching. Any water that passes through the soil will carry some fertilizer with it.

Leaching can be used to advantage by carrying soluble salts out of the soil in the bench. If such salts were allowed to remain in the soil, they would have a toxic effect on the plants when enough of them accumulated.

5. Compare the results of the different methods of watering employed with different sized plants in regard to effectiveness, required, rates of application, soil condition, and plant damage. The following form may be used for recording the data:

Breaker	Size of Plant			Size of Plant			
Time	Rate	Soil Condition	Plant Damage	Time	Rate	Soil Condition	Plant Damage

IV. Application:

Watering greenhouse crops is one of the most important operations in the entire greenhouse. Plants not only require water for their immediate needs, but they require it indirectly for getting fertilizers into usable form. The control of the force of water applied can help creatly in preventing soil compaction.

During the period of growth, from germination to maturity, a number of methods of watering may need to be employed to match the immediate needs of the plant and the soil mix. In larger greenhouses, automatic watering devices are becoming more common. This is a convenient way to cut down overhead and increase profits. Development of automatic watering devices has advanced to the point where fertilizer is mixed in correct proportions with the water before it is applied. Other devices can be regulated so that the desired amount of water may be applied to cut flower crops as well as to potted plants.

The type of watering device to be used must be chosen with consideration being given to the type of greenhouse, containers that are used, the type and size of the plants, and the cost and adaptability of the operation.

LABORATORY EXERCISE

WATERING A LAWN

I. Introduction:

Water, when properly used, will help to maintain a deep-rooted, drought-resistant turf. Deep rooting of turf can be promoted by watering heavily once a week. A general rule of thumb is that a lawn requires one inch of water (as rain or through sprinklers) per week. However, the times between watering depend on the season, weather conditions, and the type of soil involved. Soil moisture can be determined by examination of samples taken with a soil auger.

II. Objective:

Given a lawn area to water, the student will water it to maintain a deep-rooted, drought-resistant turf.

III. Procedure:

1. Using the soil auger, take several soil samples to a depth of 10 inches in the area to be watered.
2. Notice the wetness or dryness of the soil samples by color change and coolness to touch.
3. Repeat steps 2 and 3 every 3-4 days until the soil has become dry into the root zone.
4. Set up the sprinkler and place empty coffee cans at random within the watering pattern of the sprinkler.
5. Turn on the sprinkler and write down the time. When one inch of water has collected in the cans, write down the length of time it took.
6. Next take several soil samples to determine how deep into the soil the water has gone.
7. If the soil is not wet to six inches deep, continue to run the sprinkler until water has reached this depth and write down how much water must collect in the can and how much time it takes to do this. Keep these records.
8. Remove and store the equipment.
9. After one week, sample the soil again to determine whether watering is needed; repeat every three days until watering is needed.
10. When watering is needed, do it, using the time interval or accumulated water as a guide.

11. For a period of one summer month, water a lawn area to maintain a vigorously growing turf.

Note: Early signs of drying of soil in the root zone are wilting (footprints are usually clear) and a color change to slightly more bluish or purplish than normal. Under severe drought, turfgrass turns brown and becomes dormant. Turf is especially liable to damage from heavy traffic in this condition. One heavy watering will cause it to resume growth, resulting in green new growth in about seven days.

LABORATORY EXERCISE

WATERING RECENTLY PLANTED TREES AND SHRUBS

I. Introduction:

Water in plants has three vital functions. The hydrogen in water is a true nutrient and is indispensable in photosynthesis. Water also serves as the sustaining liquid in plant cells, filling them and keeping them turgid. This keeps stems upright and leaves fully extended. In addition, water serves as a carrier. Nutrients can enter plants and be used only in their ionized state, which requires an aqueous solution.

Water in the soil is classified in four groups: water bound chemically to mineral salts, water bound hygroscopically to solid soil particles as a very thin film, water held in the soil by capillary action, and water moving due to the influence of gravity.

Water that is chemically or hygroscopically bound is not available to plants. Gravitational water rapidly seeks a lower level in the soil or runs off on the surface and is of limited importance to plant growth. Capillary water is of permanent importance. The amount of suspended capillary water in soil depends on the texture and structure of the soil. The maximum amount of capillary water a soil can hold, after the gravitational water has percolated through, is called field capacity. Water available to plants is at its maximum when field capacity has been reached.

It is possible to overwater. Plant roots require both moisture and air for normal development. Adding large quantities of water too frequently to heavy clay soils may bring about a waterlogged condition. With the exclusion of air, roots decline and die, and trees and shrubs in waterlogged soils may be killed. This most frequently happens in disturbed soils when plants are located in clay fill or in potholes in clay subsoil following construction work. The soil around plants in such sites should be tile drained (see selected references under tree planting and care).

II. Objective:

Given a recently planted tree or shrub, the student will water it to develop a deep-rooted drought-resistant plant. Performance is evaluated by the teacher.

III. Procedure:

1. Using a soil auger, take several soil samples to a depth of 12 to 24 inches in the area to be watered.
2. Notice the wetness or dryness of the soil samples by color change and coolness to touch.
3. Mound earth 3-4 inches high around the plant at the edge of the planting hole.
4. Fill the mound with water at 7 to 10 day intervals during the growing season.

5. Repeat step 4 until the growing season is completed and the soil temperature is below 50°.

Note: Early signs of drying of soil in the root zone are wilting and color change of foilage.

IV. Observations:

LABORATORY EXERCISES

TRANSPIRATION

I. Problem:

Does a plant give off moisture through its leaves?

II. Materials:

Potted plant.
Large polyethlene bag.
Tie.

III. Procedure:

1. Take potted plant and water well.
2. Place large polyethylene bag over plant.
3. Secure bag well at base of stem.
4. Place set-up in sun or bright light.
5. Observe results and record.

IV. Observation:

1. Sketch apparatus.
2. Observe results.

V. Conclusions:

LABORATORY EXERCISE

WATERING PLANTS IN THE HOUSE

I. Objective:

Given a house plant determine the water requirements of the plant and then carry out a watering program.

II. Introduction:

Plants can be classified according to their water needs, and watering techniques.

1. Drench plant throughly, then allow to become moderately dry between waterings. This admits air into the soil structure which, in turn promotes development of a healthy white root system; wiry thick roots being characteristic of this group. Watering means soaking the root-ball penetratingly, holding the pot if necessary in a bucket, sink or tub of tepid water until air bubbies cease to rise. During the cold season, with steam heat in the living room, more frequent watering every day or two is required for most plants than from spring to fall. 'Feel' the soil to determine its need for water. Desert-type cacti and similar succulents will stand dryness for longer periods.

2. Evenly moist but not constant wet. Plants so classified generally have delicate, hair-like, fibrous roots, subject to rot if kept too wet, and easily burned and shriveled if too dry, especially in hot weather. Standing in a saucer, such plants may be supplied water from the base to a degree where capillary action distributes and maintains uniform moisture throughout the root-ball, without letting the soil become water-soaked and 'sour'. During resting periods and dropping temperatures the soil-ball can be kept more on the dry side.

3. Thoroughly wet, or quite moist: never allow such plants to dry out. It is good practice to keep in a saucer of gravel saturated with water, or in a jardinier, though drainage water should be emptied every few days to keep from becoming stagnant. Such subject may revel in moisture but resent having 'wet feet' that is having their roots left standing continuously in water. Exceptions, of course, are bag plants, and acquatics when not resting.

III. Procedure:

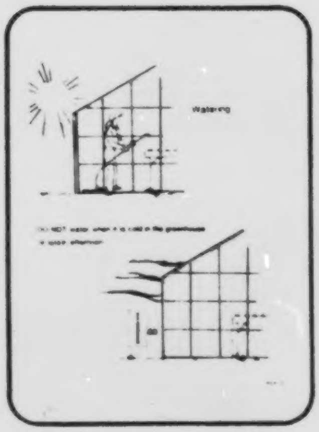
1. Identify your plant with a plant label. Include the common name of the plant as well as scientific name.

2. On the plant label put one of the three labels D (Drench), M (Evenly Moist), or W (Wet) to identify the watering requirements for future reference.

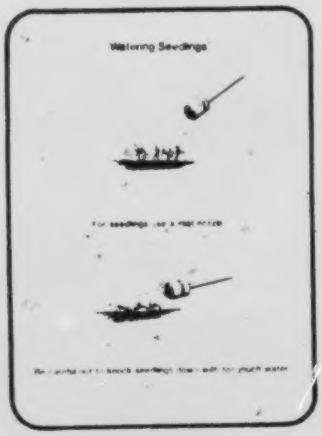
IV. Observations:

ENVIRONMENTAL FACTORS

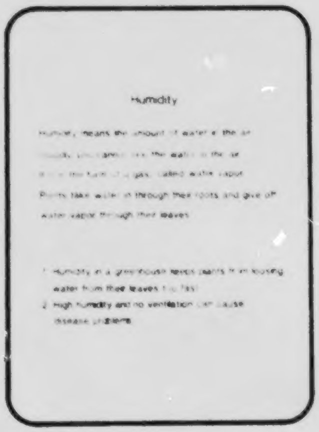
Watering



8. When watering plants inside or outside of the greenhouse, consideration of temperature around the plant is important. A plant, or the air around the plant, or a plant's soil will, to a great extent, determine how fast that plant will take up moisture. A plant that has cold roots (under 50° F.) will take up moisture very slowly. The same is true if a plant's soil temperature is over 90° F.) It is possible for this plant to have plenty of available water in the soil, but because of the temperature it is unable to absorb the water. This is typical of cold greenhouse soils in the winter, and turfgrass in mid-summer. Misting of the plant may be necessary. Generally, it is recommended that a plant be watered early in the day so the top of the soil is dry to the touch by the end of the day. This will eliminate diseases perpetuated by poor watering practices. Watering on a cloudy day should be kept to a minimum.

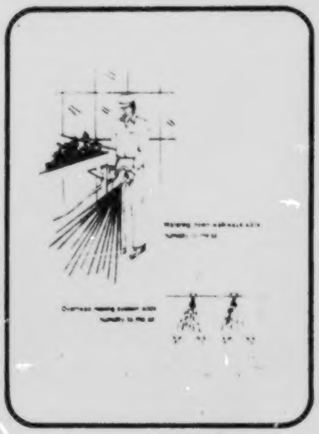


9. When watering, use water that is slightly warmer than air temperature, or if you cannot regulate water temperature, make sure the water temperature is generally about 75° F. If you are watering cool season crops, that are grown about 55° F., make sure the water is only about 5° warmer. Water that is too warm may damage crops just as water that is too cold. During the winter a plant might need watering once a week, but the same plant may need daily watering in the summer.

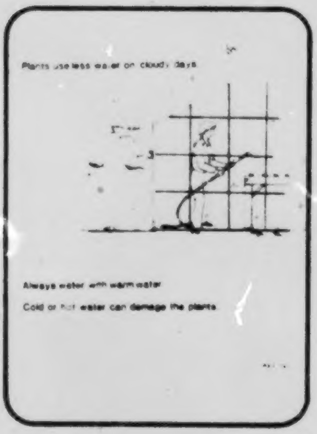


Humidity

10. When watering with a water wand, or other watering techniques, adjust the water to the correct flow or water pressure. Plants grown in a greenhouse bench that are watered from one side of the bench, can cause problems. Soil tends to get pushed to the back of the bench and the water will then concentrate in the lower locations of the bench. Another problem arises because plants tend to become over watered when hand watering. When hand watering plants planted in the bench, attempt to water with the nozzle head perpendicular to the top of the bench. Avoid splashing water on the leaves of the plants. Over watering is also a problem with automatic watering.



11. When watering plants in a bench, be sure that each pot gets the proper amount of water. The color of pot, the size, the drainage hole, the soil media mix, the firmness of planting media, the size and health of cuttings, and the location of the pot in the bench all determine how the plant will react to watering. If there is too much soil in the pot, the plant will not get enough water, and if there is too little soil in the pot, the plant will be over watered. Pots on the side of the bench will dry out faster than pots in the middle. Pots on the south side of the bench will dry faster than pots on the north side of the bench. Plants in close proximity to each other will require less water than plants spaced farther apart. All of these considerations suggest that each pot will require a different watering pattern. This is perhaps the most difficult operation to learn in horticulture. These principles can be applied to plants growing in the home and outdoors.

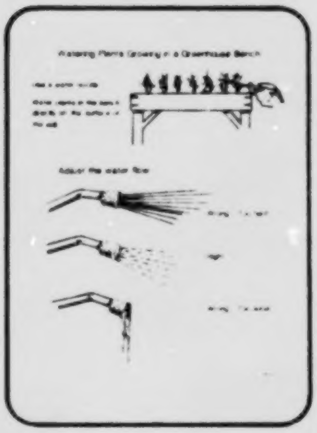


Plants use less water on cloudy days

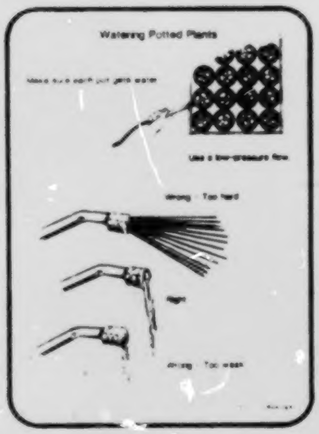
Always water with warm water

Cold or hot water can damage the plants

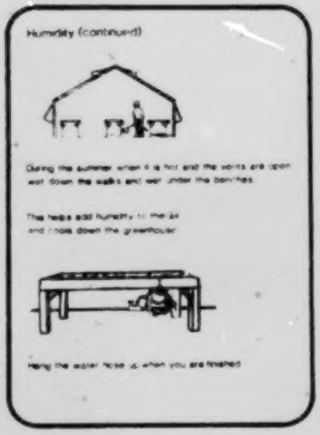
12. It is possible to regulate the development of a seedling by the method of watering. Plants can be kept short and stocky by infrequent but thorough waterings. New seedlings, once germination has begun, must be kept moist until they are well established. A common mistake in germination of seeds in the greenhouse and the germination of a seeded turf area is allowing the soil media to dry out before the plants are estabished. Be conscious of excessively warm temperatures and watering practices, because elongation may result. Consider using a specific mist nozzle developed especially for watering seedlings. Adjust the distance of the nozzle to the seedling depending on the water pressure.



13. The control of humidity is directly related to the keeping quality of fruit and vegetables. Humidity must also be controlled in greenhouses growing crops requiring high humidity such as ferns and low humidity requiring crops such as cactus. These are extreme examples but each has a specific humidity that is its optimum. Low humidity generally results in desication and wilting, while high humidity can favor fungi and bacterial growth. Temperature and humidity have a direct relationship and must be closely watched. For example, high humidity and cool air temperature but warm soil temperature is recommended for the rooting of many cuttings. Warm air temperature will stimulate the top to grow and root formation will be slowed. At lower temperatures, humidity is easier to maintain, and plants will loose water less rapidly through transpiration.


Watering Potted Plants
Use a low-pressure flow
Wrong - Too hard
Right
Wrong - Too weak

14. In the greenhouse, watering down walkways and evaporation of that water add humidity to the air. This method is not as effective when a ventilation system is in operation and air movement occurs. Overhead misting is a common practice in propagation greenhouses. During the winter months, this method proves to be effective. Be sure to hang up hoses when finished.


Humidity (continued)
During the summer when it is hot and the vents are open wet down the walks and wet under the benches
This helps add humidity to the air and cools down the greenhouse
Hang the water hose up when you are finished

15. During the summer months when the ventilation system is open, many greenhouse growers will mist their crop to cut down on the evaporation of moisture from the leaves. This might be done several times a day, but water quality must be considered. If the water is high in minerals, evaporated water from the leaves will result in mineral deposits on the leaves, misting might do more damage to the leaves than the transpiration. As always, replace the equipment that you have used to its proper location for storage.

SAMPLE TEST QUESTIONS

1. What effect does frequent light waterings have on plant materials?

2. Why is it important to water immediately after transplanting?

3. What are the disadvantages of saucer watering?

4. What effect does plant spacing have on frequency of watering?

5. How does water affect seed germination?

6. How does water affect disease dissemination?

7. What alternatives are available for a source of water?

8. What factors are considered in determining how frequently to water?

9. Describe or give the purpose of the following automatic watering system:
    a. Gates Peripheral:
    b. Ohio Circular:
    c. Greco:
    d. Chapin Ooze Tub:
    e. Sub Irrigation:
    f. Capillary Mats:

10. What role does water play in photosynthesis?

11. What conditions bring about water loss via transpiration?

12. What effect does other environmental conditions have on water?

13. What is the effect of water loss on leaf temperatures?

14. How does air movement affect water loss?

15. Define the following terms:

    a. Transpiration:

    b. Exudation:

    c. Guttation:

    d. Wilting:

    e. Permanent wilting point:

    f. Respiration:

    g. Over watering:

    h. Underwatering:

    i. "Wet Feet":

    j. Field capacity:

16. If used for house plant watering, why might Zeolite water conditioners be a problem?

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: PRUNING, PINCHING AND DISBUDDING PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshman or beginning students in a horticulture or agriculture program. The recommended time for teaching this probelm area is during the fall semester.

The estimated instructional time for this problem area is 10 to 15 days depending on how far the teacher wishes to go in developing pruning, pinching and disbudding skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instructional can be 4 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased. Growing crops such as coleus can act as an excellent example of pinching a crop to increase the density of the plant. Mums also provide a pinching example as well as disbudding example. Pruning should concentrate on objectives of pruning with practical experience on decidious shrubs and hedges. The pruning of trees should be left for advanced class work.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this problem area are for reference or modification as instructors adapt this material to their local situation.

CREDIT SOURCES:

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The teacher's guide, laboratory exercises, and test questions were developed by Jim Ethridge. Transparency masters and the transparency discussion guide were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers. The laboratory exercises on "Pruning Decidious Shrubs" was adapted from materials developed from a horticulture task sheet prepared by the Department of Agricultural Education. The Pennslyvania State University.

TEACHER'S GUIDE

I. Unit: Growing and managing horticultural crops

II. Problem area: Pruning, pinching, and disbudding plants

III. Objectives: At the close of this problem area students will --

1. Develop an understanding of reasons for pruning, pinching and disbudding plants.
2. Identify basic tools used in pruning and demonstrate their proper use.
3. Develop an ability in pruning techniques to be used on shrubs, and evergreens, and pinching and disbudding techniques to be used on herbaceous plants.
4. Identify influencing factors that affect the pruning operation.

IV. Suggested interest approaches:

1. Tour the area to show proper and improper training and pruning.
2. Conduct a class discussion on "Why should we prune?" and "Why not leave well enough alone?"
3. Use VAS slide sets and drawings or overhead transparencies explaining pruning.
4. Display examples of pruning equipment and have the instructor demonstrate the proper use of the equipment.
5. Have students demonstrate practical applications of pruning.
6. Collect specimens of "Why Prune" such as rubbing branches, suckers, water sprouts, disease branches, etc.
7. Take a trip to a nursery to observe root pruning and pruning within a nursery.
8. Root prune greenhouse plants which are pot bound.
9. Pinch opinsettia crop and/or mum crop showing branching effect.
10. Disbud a mum crop showing various techniques of disbudding.

V. Anticipated problems and concerns of students:

1. Why prune?
2. What parts of the plant do you prune?
3. What tools do you use to prune?
4. When do you prune?
5. Where do you cut when pruning?
6. How do you prune hedges?
7. How do you prune roses? Hybrid T, Grandiflore, Floribunds, Standard.
8. How do you prune ornamental vines?
9. How do you prune fruiting vines and shrubs?
10. How do you disbud?

VI. Suggested learning activities and experiences:

1. Disbud a mum crop showing various techniques.
2. Pinch coleus, poinsettias, azaleas, mums, Sweedish Ivy, wandering jew.
3. Prune actual plant materials (decidious shrubs, and evergreen shrubs).
4. Have students read University of Illinois Circular on "Pruning" and record tentative answers to the problems and concerns identified by the class or teacher.
5. Show transparencies
6. Compare pruning shrubs to pinching of herbaceous plants and mowing a lawn.
7. Identify a plant for the students and have them react as to how it should be pruned, keeping in mind its characteristic shape and form and the desired shape and form for this location.
8. Root prune greenhouse plants which are pot bound.
9. Display examples of pruning equipment and have someone demonstrate the proper use of the equipment.
10. Conduct a class discussion on "What is Pruning?" and "Why should we prune?".

11. Show VAS Slidefilms 615 - "Objectives of Pruning" and 643" - "Pruning Evergreens."

VIII. Application procedures:

1. The main purposes of this problem area are to teach information and develop skill in the pruning, pinching, and disbudding of plant material.
2. The performance phase should be emphasized in on-the-job training, supervised projects and work on the home landscape of the students.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test using Sample Test Questions as possible test items.
2. Have students perform specific pruning activities and evaluate their performance.

IX. References and aids:

1. 50 Laboratory Exercises for Vocational Ornamental Horticulture Students, Paul Hemp. The Interstate Printer and Publishers, Danville, Illinois p. 47 "Pruning Shrubs".
2. 50 Laboratory Exercises For Vocational Ornamental Horticulture Students, Paul Hemp. The Interstate Printer and Publishers, Danville, Illinois pp. 49-50. "Pruning Hedges".
3. 50 Laboratory Exercises for Vocational Ornamental Horticulture Students, Paul Hemp. The Interstate Printer and Publishers, Danville, Illinois pp. 121-122, "Effects of Pinching on Lateral Growth".
4. All about Pruning, Ortho Book, Chevron Chemical Company, Ortho Division 575 Market Street, San Francisco, CA. 94105.
5. Pruning Handbook, Sunset Books, Lane Publishers, Menlo Park, CA.
6. Ball Red Book, 13th Edition, 1975 p. 252, 256, 257, 265.
7. University of Illinois, Cooperative Extension Service Circular N. C. 1033 Pruning Evergreens and Decidious Trees and Shrubs pp. 3 to 7, 13 to 22, 37 to 40.

8. Laboratory Exercises on:
   - A. "Pinching Plants"
   - B. "Pruning a Tea Rose"
   - C. "Pruning a Decidious Shrub"
   - D. "Disbudding Plants"

9. Vocational Agriculture Service Slide Sets:
   - A. #S 643 "Pruning Evergreens"
   - B. #S 644 "Pruning Decidious Shrubs"
   - C. #S 615 "Objectives of Pruning Decidious Trees"

10. University of Illinois Cooperative Extension Service, Horticulture Facts,
    - A. LH 480 "Planting and Caring for Hedges"

INFORMATION SHEET

"PINCHING AS IT RELATES TO MUMS"

SINGLE STEM VS. PINCHING

In order to achieve the maximum amount of crops per year, single stem cut mum crops should be grown The major economies available from single stem growing are:

1. The labor associated with training and performing the pinching and pruning operation is eliminated. Frequently it is the failure to perform these functions correctly and on time that significantly reduces quality.

2. Single stem crops allow for shorter crop duration and as such permit more frequent flowering with the same area as well as tending to reduce the overall growing costs for any one crop. If something should happen to one crop on a single stem basis, it is not as significant a loss because the grower can replant and flower another crop in much less time than he or she can on a pinched basis.

3. Single stem crops planted from September 15 to March 1 produce a more uniform crop with greater flower size and better spray form than a pinched crop grown during the same period.

On the same given bench area, single stem culture will produce one extra crop every two years. This increase in production as well as the associated increase in quality more than pays for the increased cutting cost. Another significant reduction is in the time required to light a single stem crop. Especially for year-round production of cut mums, a reduction fo 3 to 5 weeks of long days can result in a very substantial reduction in the electric bill at the end of the year.

Pinched crops should be pruned back to 3 stems on the outside row and 2 in the center. Disbuds and fast crops can carry 3 stems per plant in the summer and fall, the same as pomps during the winter and spring.

Spacing methods are as varied as greenhouses. The above recommendations take into consideration dark weather conditions experienced by the northern grower. Actual space used will vary depending on a grower's experience and the type of market he or she serves.

Wire or nylon mesh can be used to advantage as a planting guide if the squares are of the proper size. One or more cuttings can be put to a square, thus eliminating the marking of a bench.

Pinching should be done at the proper time to insure good spray form, provide additional stems which can be flowered, and produce the proper type bud formation (crown or terminal).

Plants pinched too early produce crown buds, and the laterals which develop from this type bud are uneven in flowering response. Plants pinched too late provide a shortened stem and clubby spray.

For natural season crops the date of pinching is especially important. Proper pinching will determine the spray and type of bud formed. Varieties are most important.

HOW TO PINCH - There are three types of pinch:

1. Hard - removing two or more inches of stem. Not recommended, but often used to produce an extra cutting. This type pinch goes back into hard wood and breaks are slow to develop. It also means that the cuttings have to be grown longer to achieve sufficient height for this type pinch.

2. Soft - made in new, soft growth rapidly producing vigorous breaks. Generally not more than one inch is removed.

3. Tip or roll-out - This is the softest of all pinches and generally produces the greatest number of breaks. Care must be taken to remove all the growing tip or the plant may continue to grow as a single stem.

All three pinches should be made with the fingers. Knives and other instruments may spread disease such as bacterial blight.

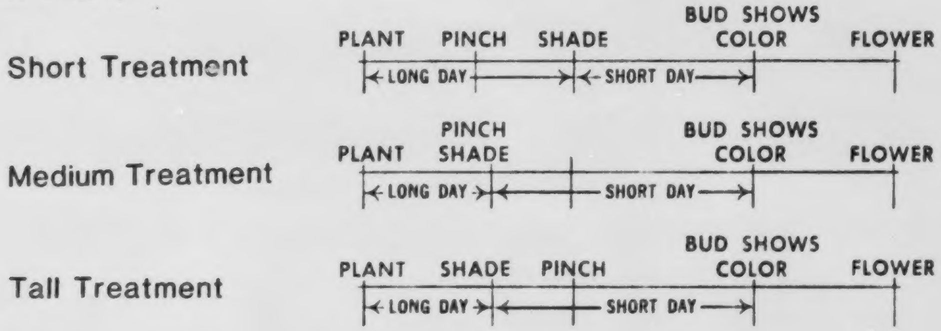
The most common error made in pruning is waiting until the breaks get too big. This not only produces a check in growth but also increases the danger of tearing the stem when the break is removed. Late pruning leaves a wound in the stem which is an avenue of entry for disease.

Some growers remove all the leaves below the pinch at the time of pruning. This is supposed to increase air and light to the plant and facilitate watering. One thing it does is remove much of the plant's ability to manufacture food and produce strong stems.

Pinched pompons and standards are generally pruned to 2 stems on the inside rows, 3 on the outside row. Disbuds and fast crops generally are grown with the same number of breaks as pompons.

Most pot mums are grown pinched. This produces more flowers per plant and the pinch is a means of height control.

Depending on the vigor of the variety and ultimate height of the plant desired, the pinch may be made before, on or after the start of short days (see chart).


Short Treatment
PLANT
PINCH
SHADE
BUD SHOWS COLOR
FLOWER
LONG DAY
SHORT DAY
Medium Treatment
PLANT
PINCH SHADE
BUD SHOWS COLOR
FLOWER
LONG DAY
SHORT DAY
Tall Treatment
PLANT
SHADE
PINCH
BUD SHOWS COLOR
FLOWER
LONG DAY
SHORT DAY

The majority of the pot mum growers use a single pinch method. This produces from 5-6 cuttings per 6 inch pot, a good number of stems and flowers which bloom evenly. The plants should be pinched according to the dates found in a pot mum schedule.

Single stem pot mums are increasing in popularity with the improvement in growth retardants. Seven to eight cuttings are planted per 6 inch pot or 10 to 12 cuttings to an 8 inch pot. No pinch, and short days are started the day of planting. Some areas find it necessary to light one week during the winter to achieve good height.

Each stem is disbudded as early as possible leaving only the terminal bud. Reduced crop time and more crops per year out of the same square foot area offset the increasd cutting cost per pot.

DISBUDDING

Disbudding of standards and disbud crops is one of the major costs of producing a cut flower crop. If it is not done properly and on time, the dollar return of that crop will suffer.

As soon as the lateral buds are large enough to be rolled out easily without endangering the terminal, the plant is ready for disbudding. Starting at the top and disbudding down the stem; that way, if the terminal should get broken out, the next lateral bud can be allowed to bloom. Although these blooms are always smaller and on a "dog-leg" stem, they can at least be sold as bunch mums with some return.

Late disbudding not only decreases the size of the flower, but can cause varieties to become "necky". That is, have several inches of stem between the last leaf and the flower head. If the laterals are allowed to increase too much in size, their removal will leave an open wound in the stem; disease organisms would have no problem entering.

CENTER BUD REMOVAL

Many pompon varieties benefit from central bud removal. This operation, while time consuming, will produce a better, more open spray form and a stem which flowers more uniformly.

The center bud will flower first, simply because it is more mature than the laterals. For this reason, some retail growers wait until the bed opens before removing it. This produces a short stem bloom for corsage or small arrangement work. Although this is getting the maximum production out of any individual stem, it should not be used as a substitute for center bud removal. This operation is done too late to be of any benefit to the spray form.

As soon as the lateral buds have developed sufficiently, the center or terminal bud should be snapped out with the fingers. This gives the plant sufficient time to develop the best possible spray form. Center bud removal is not detrimental to any pompon variety.

Pot mums should be disbudded the same as standards; when the buds can be handled easily, but as soon as possible. Delay in disbudding will reduce the flower size and quality of pots the same as cut mums.

NATURAL SEASON CROPS

Although natural season crops can be produced without lighting or shading, which reduces the cost of production, this lack of control is one of the greatest shortcomings of this crop. Unexpectedly high summer and/or early fall temperatures can retard bud initiation and delay flowering. A late fall, when the days remain warmer and brighter than normal, may also delay bud initiation and slow down the early stages of bud development. This combination of high temperature and sunny days causes the greatest delay with the 11 through 14 week varieties. The 9 and 10 week varieties are more tolerant of higher temepratures for bud initiation and development. Delayed flowering is therefore seldom a problem with them; however, with this combination of conditions, the size of flowers is often reduced.

Many varieties with a listed normal blooming date of say December 10, can often be cut before Thanksgiving. Some of this earliness can be attributed to a warm, bright fall, thus producing smaller underdeveloped flowers. However, the basic reason flowering is earlier, is that the lower than average summer night temperatures permitted earlier than normal flower bud initiation and development.

STUDENT WORKSHEET
PINCHING PLANTS

I. Objective:

To learn how to pinch back plants.

II. Introduction:

Pinching back makes the plant grow shorter and bushier. Pinching makes more but smaller flowers. Pinching back makes plants grow more uniform.

III. Materials:

One of the following plant materials makes for a suitable pinched crop: coleus, mum, poinsettia, fuschia, petunia, dahlia

IV. Procedure:

1. Pinching can be done on any plant that has actively growing shoots.
2. Remove only the growing tip (aout 1/2 inch).
3. Pinch out with the thumb and index finger, the pinch should snap out.
4. Do not even the pot by pinching some harder than others.
5. Growth should begin within two weeks.
6. Growth should be aoout one inch long within three weeks.

V. Observations:

Note: Most plants are single pinched for commercial production but hanging baskets, and house plants may be pinched continuously. Garden mums may also be pinched several times during the vegetative growing season before the set of flower buds.

STUDENT WORKSHEET
DISBUDDING PLANTS

I. Objective: To learn how to disbud plants

II. Materials:

A flowering plant with multiple flowers per stem some examples include mums, peonies, dasies, calendula, gladiola.

III. Introduction:

Disbudding is the removal of the side buds on the stem leaving only the central bud. This central bud will grow much larger when the side buds are removed. Leave the top most remaining bud for its replacement. This bud will eventually flower but it will be later than other central buds that have been left to develop on other plants.

IV. Procedure:

1. Determine with the aid of the instructor when the buds are large enough to remove. The buds will usually have stems of about 1/2 inch long.
2. Disbud using the thumb and index finger. The stem of the bud should be removed back to the main stem.
3. Avoid using a knife or other tool, as the tool can spread disease.
4. If grown too tall, disbudded flowers may need additional support.

V. Observations:

Note: Another form of disbudding is sometimes used in commercial production of mums. That is the removal of only the center bud and allowing only the side buds to develop. Your instructor will demonstrate this alternative method of disbudding.

STUDENT WORKSHEET
PRUNING A TEA ROSE

I. Objectives:

The objectives of pruning tea roses are simply to promote a symmetrical bush, to encourage new growth, and to remove any disease, damaged or dead wood.

II. Introduction:

Different classes of roses have their own pruning requirements. It is recommended to prune after the coldest weather is over and leaf buds are beginning to swell. Annual pruning of roses is made simpler if the roses have been picked and trimmed throughout the growing season.

III. Procedure:

1. Make all cuts on a 45^{0} angle 1/4" above a bud.
2. Remove all dead canes
3. Remove twigs smaller than a pencil's diameter.
4. Open up the center of the bush by removing cross over branches.
5. Remove suckers below the graft union.
6. Remove old canes that produced weak growth the previous year
7. Rake up all old leaves and prunings and dispose of these materials.
8. Put away all tools.

IV. Observations:

STUDENT WORKSHEET
PRUNING DECIDIOUS SHRUBS

I. Objective:

Given available deciduous shrubs and proper tools, prune shrubs to desired form.

II. Introduction:

Deciduous and evergreen shrubs often require pruning to improve their appearance. Pruning promotes compact growth, develops natural form, and removes dead wood. Pruning is done before growth starts in early spring for plants that bloom in mid-summer. Spring-flowering shrubs are pruned right after flowering. Most deciduous shrubs require some maintenance pruning each year.

Note: This pruning exercise is for deciduous shrubs being grown in natural form. Different methods are used for hedges and formal shapes. Evergreens and trees require other special methods. Garden roses, vines, fruit trees, and espaliered plants are each pruned differently.

III. Procedure:

1. The teacher will select the shrub needing pruning. Before starting to prune, notice the natural form of the shrubs.
2. If a stem is dead all the way down, it should be removed at the ground line. Do not leave any stubs. Remove all dead wood, making smooth cuts at the live branch, using shears.
3. Where two branches rub together, remove the less desirable branch by making a smooth cut at the lateral branch.
4. Cut back extra long branches that disturb the natural plant form, making a smooth cut at a lateral branch. This is called "heading back."
5. Remove branches that overhang a walk or driveway. Cut back to leave the strongest branch that does not extend into the walk or driveway. Make a smooth cut.
6. If there are isolated, new, very strong shoots from the base, cut off the tip about 18 to 24 inches from the ground to encourage branching. This will help in keeping the natural plant shape.
7. Using tree paint, (a special paint that is not harmful to plants) paint cut surfaces that are over 1/4 inch in diameter.
8. Remove clippings; clean and store tools.

SAMPLE TEST QUESTIONS
PRUNING

1. What is rejuvenation?

2. How is pruning in the nursery different from pruning done in the home landscape?

3. Why do we prune roots in the nursery?

4. How do we root prune pot-bound plants in the home?

5. What is a "Standard" plant?

6. What is thinning out?

7. What is leaf abscision?

8. How can plant growth be regulated?

9. Identify examples of genetic control of plant growth?

10. Identify examples of cultural control of plant growth?

11. Identify growth regulating substances of vegetative growth?

12. How does one direct plant growth by pruning?

13. Why prune?

14. What is directing growth?

15. What is thinning?

16. What is heading back?

17. What are the principles of shaping?

18. Why do you prune roots?

19. When do you prune?

20. What is pinching?

21. Why pinch rhododendron?

22. When do you prune spring flowering shrubs?

23. When do you prune summer or fall flowering shrubs?

24. What is rejuvenation pruning?

25. What is a temporary branch?

26. What is a water sprout?

27. What is vase pruning?

28. What systems of disbudding exist?

29. Identify the six basic reasons for pruning plants.

1.

2.

3.

4.

5.

6.

30. Explain how the season would affect the pruning operation as to timing and severity of the operation.

31. When might the following pruning styles be implemented?

a. Pinching:

b. Heading back:

c. Thinning out:

d. Topping:

e. Side pruning:

f. Directional pruning:

g. Drop crotching:

h. Expalier:

i. Topiary:

32. Identify six typical limb or structure developments or conditions that should or could be corrected by pruning.

1.

2.

3.

4.

5.

6.

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: PLANTING PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshman or beginning students in a horticultural of agricultural occupations program. The recommended time for teaching this problem area is during the spring semester. It is suggested that the instructor provide a wide group of experiences in planting sod, seeding a lawn, planting trees and shrubs, and transplanting house plants.

The estimated instructional time for this problem area is 8 to 10 days depending on how far the teacher wishes to go in developing planting and transplanting skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instructional can be 5 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this problem area are for reference or modification as instructors adapt these materials to their local situation.

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TEACHER'S GUIDE

I. Unit: Growing and managing horticultural crops.

II. Problem area: Planting plants.

III. Objectives: At the close of this problem area students will be able to--

1. Identify a container suitable for planting plants.
2. Transplant seedlings from a flat to a suitable container.
3. Understand the major factors involved in the proper planting of trees, shrubs and herbaceous plants.
4. Select the proper stage of growth for transplanting seedlings.
5. Select the proper size container to transplant.
6. Root prune plants too large for their pot size.
7. Demonstrate the correct spacing in a multi pak.
8. Demonstrate the correct planting of bulbs in the greenhouse.
9. Properly double pot plants.
10. Demonstrate procedures to follow before and after transplanting seedlings.
11. Demonstrate familiarity with terms pertaining to care and transplanting of seedlings.
12. State the process by which seedlings are hardened and give reasons this process.
13. Identify the steps to follow after transplanting.
14. Transplant a seedling properly.

IV. Suggested interest approaches:

1. Collect all possible containers for a display. The collection should include bulb, azalea, standard and rose pots. This collection should also include plastic, clay, metal, fiber and peat pots. The pots should be round, square, varied colors with round holes and square holes on the bottom and side. The pots should also have varied ridges on the bottom of the container. All of these characteristics should be discussed and how they affect growth.

2. Take the pot bound plants in the greenhouse and transplant some up into a larger size pot and come to a conclusion as to why that pot size was chosen or root prune plants and return the plant to its original container.

3. Have on hand iris bulbs, tulips, hyacinthis crocus and lilies and demonstrate how each are cared for and planted differently.

4. Take a trip to a nursery or landscape area and observe mechanical transplanters. Identify common equipment used in commercial transplanting of trees. Also observe commercial digging of shrubs.

V. Anticipated problems and concerns of students:

1. When is the best time for transplanting?
2. How do I prepare the soil for transplanting?
3. How do I prune roots before transplanting?
4. How do I plant a tree or shrub?
5. How do I stake a tree at transplanting?
6. Why do I mulch a tree at planting time?
7. Are some plants mechanically transplanted?
8. At what spacing do I transplant plant materials?
9. How do I calculate transplanting loss?
10. What containers should be used?
11. How do we select seedlings for transplanting?
12. What transplanting techniques are used in greenhouses?
13. What is "hardening off" of plants?
14. What are the shoulders of a potted plant?
15. What is over potting?
16. How deep should you plant cuttings?
17. How much area does one need to plant a particular crop?
18. What container do I use in planting a particular crop?

19. How does planting depth affect the growth of the plant?

20. Why do we lose newly planted transplants?

21. What are the proper methods of handling transplanted seedling, trees and shrubs.

22. Why does one "size out" transplants and cuttings before transplanting?

23. How does one determine the proper size of hole to plant a tree or shrub?

24. How does one prepare "back fill" after facing the tree or shrub?

25. What considerations are used when facing a tree or shrub?

26. How does one "lip" a newly planted tree or shrub?

27. Why does one prune a newly planted tree?

28. What containers are available for transplanting plants?

29. What are the advantages and disadvantages of each container?

30. How do I repot my house plants?

31. When do I transplant seedlings?

32. What is double potting?

33. What market packs are available?

34. Why do the holes in containers differ?

35. How do I transplant seedlings from a flat to a cell?

36. How do I can a rooted liner?

37. What are the proper steps in establishing lawn from sod?

38. At what size should seedlings be transplanted?

39. Why root prune?

VI. Suggested learning activities and experiences:

1. Have students transplant various types of plants which are bareroot, balled and burlapped, and container grow stock or greenhouse crop.

2. Give students examples of wrapped and staked trees some of which are properly done and others that are not and have students indicate those which are done satisfactorily.

3. Have students establish a small turf area by plugging or stolonizing and strip sodding and compare the sites.

4. Have students decide when a flat of seedlings should be transplanted and have them transplant the seedlings.

5. Allow some seedlings to become too large and have students root prune the seedlings as transplanting occurs.

6. Determine stage of development for transplanting seedlings.

7. Transplant seedlings.

8. Transplant trees and shrubs (bareroot, container, balled and burlapped).

9. Plant "bulbs" (iris, tulip, lily, crocus).

10. Take a field trip to observe nursery transplanting of trees and container planting of nursery stock.

11. Field line nursery stock.

12. Double pot plants for displays.

13. Root prune house plants and replants.

14. Determine the space of a poinsettia crop at transplanting to the final spacing.

15. Size cuttings prior to planting of mums and discuss.

16. Plant bulbs in the landscape and discuss the difference between this method and planting bulbs in pots. Set up demonstrations showing effects of proper and improper planting techniques.

VII. Application procedures:

1. The main purpose of this problem area is to teach information and proper planting techniques.

2. Transplanting could be done to beautify the school grounds as a community service project.

3. Have students make charts of proper planting, staking, and wrapping operations for use for giving demonstrations to other classes or groups.

4. Have students wrap, and stake, newly planted trees and shrubs.

5. Have students read articles provided on planting and transplanting.

6. Additional activities should be conducted in the land laboratory or on-job-training or in the school greenhouse.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test using sample test questions as possible test items.

2. Collect and grade laboratory exercises.

3. Observe and grade performance in the proper planting of sod or nursery stock or herbaceous plants.

IX. References and aids:

1. University of Illinois, Cooperative Extension Service, Horticulture Facts,

   A. LH 2 79 "Planting Shrubs"

   B. LH 4 80 "Planting and Caring for Hedges"

   C. FL 12 80 "Planting and Maintaining a Terrarium"

   D. FL 1 79 "Indoor Gardening"

2. 50 Laboratory Exercises for Vocational Ornamental Horticulture, Compiled by Paul Hemp, The Interstate Printers and Publishers, Danville, Illinois.

   A. "Removing Plants from Pots for Repotting or Transplanting" p. 11 and 12

   B. "Preparing a Terrarium Showcase for Small Plants" pp. 13 to 16

   C. "Planting a Balled and Burlapped Tree" p. 43 and 44

3. Laboratory Exercises on:

   A. "Transplanting Seedlings into Flats"

   B. "Planting Amaryllis Bulbs for the Greenhouse"

   C. "Transplanting Rooted Cuttings into Pots"

   D. "Putting Pots into Place after Planting"

   E. "Transplanting Plants from one Container to another Larger Container"

  F. "Planting Container Grown Trees and Shrubs"
  G. "Planting Bare Root Trees and Shrubs"
  H. "Planting Hardy Bulbs"
  I. "Planting Annual Flowers"
  J. "Repotting Plants"
  K. "Planting a Balled and Burlapped Shrub"

4. Transparencies and Transparency Discussion Guide

5. Sample Test Questions

6. Vocational Agriculture Service Unit:
  A. # 5002 "Transplanting Shade Trees"

7. Vocational Agriculture Service Slide Sets:
  A. # S 613 "Planting and Care of Hanging Baskets"
  B. # S 647 "Planting a Terrarium"

LABORATORY EXERCISE

TRANSPLANTING SEEDLINGS INTO FLATS (WITHOUT CELL PACKS)

I. Purposes:
  - A. To demonstrate optimum growing space, food, light, and water for seedlings
  - B. To demonstrate uniformity in the flat
  - C. To transplant seedlings into flats (without cell packs)

II. Soil Mixture: The best kind of soil for this operation is made up of equal portions:
  - A. Compost or rich garden soil
  - B. Sand
  - C. Peat moss

III. Materials and Equipment:
  - A. Flat
  - B. Dibble board
  - C. Soil mix
  - D. Paper
  - E. Label
  - F. Wax pencil
  - G. Watering can

IV. Procedure:
  - A. Obtain necessary materials and equipment
  - B. Place one thickness of paper in bottom of flat (if the flat has open spaces)
  - C. Fill flat full of soil mix
  - D. Scrape off excess soil
  - E. Firm soil
  - F. With a dibble board, make one row of holes
  - G. With a trowel carefully remove some seedlings from seed flat
  - H. Take each seedling and holding it by one leaf, insert roots into hole
  - I. With thumb and forefinger of each hand, firm soil around seedlings
  - J. Complete rest of flat
  - K. Lift flat one inch from table and gently drop flat on table to fill air apaces in soil
  - L. Label your work as directed and place your label on top right corner of flat
  - M. Move flat to designated area and water
  - N. Clean up work area

V. Observations:

LABORATORY EXERCISE

PLANTING AMARYLLIS BULBS FOR THE GREENHOUSE

I. Objective: To become familiar with various bulbs and how to grow them in the greenhouse.

II. Materials:
1. 4" - 5" pots for single bulbs
   6" Azalea pot or bulb pan
   6" - 8" standard pot
   Adopt the container to the bulb
2. Soil, water, pebbles, water, moss, perlite and fiber
3. The best soil mixture for bulbs is
   a. 1/2 bushel sphagnum peat moss
   b. 1/2 bushel horticultural-grade perlite
   c. 2 ounces 20% superphosphate
   d. 4 ounces complete fertilizer (5-10-5 analysis)
4. Bulbs to be planted
5. Plastic plant labels
6. Soil sterilant - Morton's Soil Drench

III. Tools and equipment:
1. Greenhouse bench
2. Mixing shovel
3. Spay nozzle and hose
4. Soaking vat for sub-irrigation

IV. Procedure:

A. Use prepared media mentioned under materials.
B. Place bulb in media so that 2/3 will remain above soil surface.
C. Tamp soil firmly around bulb.
D. Water bulbs thoroughly after potting.
E. Bulbs may be watered gradually from the surface or be subirrigated.
F. The temperature should be kept from 55° to 60°F.
G. The pot should be placed in a moist dark place for a period of 6 to 12 weeks.

V. Observations:

LABORATORY EXERCISE

PUTTING POTS INTO PLACE AFTER PLANTING

I. Objective: Given two varieties of potted plants, line pots in growing bench bed, or coldframe, with correct labeling.

II. Introduction:

A general formula to remember when potted plants are placed on a bench or in a bed or cold frame is to place the pots in rows from the front to the back, and from left to right. This orderly arrangement makes finding the plants easy, and is used in both nursery and greenhouse businesses.

It is important when moving plants to know where one variety stops and another begins to prevent mixing varieties.

III. Note: When potted plants are removed from a place, they are usually removed in the same order in which they were put into place; the labeled plant first, followed in order by the rest.

IV. Procedure:

1. Place the first pot of a variety at left front. Place additional pots from front to back until finished.
2. Place label in the first pot of each variety.
3. Place the next variety immediately after the last pot of the first variety. Continue from front to back and left to right.
4. Water each pot twice to be sure the entire soil volume is wet.

V. Observations:

LABORATORY EXERCISE

TRANSPLANTING PLANTS FROM ONE CONTAINER TO ANOTHER LARGER CONTAINER

I. Objective: Given a recommended soil mixture, potted plants, and containers, transplant nursery stock from the pot to the container.

II. Introduction:

Cuttings, seedlings, or grafted plants of many kind are grown for a period of time in small pots until they are large enough to be transplanted into larger containers, or lined out in the bench.

III. Procedure:

1. Water the potted plants about 30 minutes before transplanting.
2. Remove the plant from the pot by holding the stem of the plant between fingers, and strike rim of pot against edge of bench. Do not break soil ball or root damage will result. Plants grown in pressed peat pots are planted without removing the pot.
3. Fill the container about 1/3 full with soil and add the plant. Adjust the planting depth of the plant to about 1/4 inch to 1/2 inch below the rim of the container, adding or removing soil under it as needed.
4. Loosely fill soil in the container and level it off with the hand. Press the soil on each side of the plant until the soil is about 1 inch from the top of the container.
5. Water the plant by filling the container to the rim twice. Thereafter, the plant should be watered at the rate of one pint per gallon size container once per day in fall and spring; twice per day in the summer.

IV. Observations:

LABORATORY EXERCISE

TRANSPLANTING ROOTED CUTTINGS INTO POTS

I. Objective: Given rooted cuttings, a soil mixture, and pots, transplant cuttings from the flat or bench to pots.

II. Introduction:

Rooted cuttings may be potted singly in small pots with the intention that they will later be transplanted into large pots, or several cuttings may be planted in one large container in which they are to be sold.

The roots or cuttings are easily damaged in the potting process, so it must be done carefully. Speed in potting develops with experience.

Large firms which produce plants for potting often use machines that make the work easier and faster.

III. Note: If there is more than a 20 to 30 minute delay between potting and moving transplanted cuttings to the place where they will be grown, the plants should be thoroughly watered right after potting.

IV. Procedure:

1. Place pots to the left of the potter; the soil, directly in front of the potter; and the flat of rooted cuttings close to the right of the soil. Keep cuttings moist.
2. Pick up pot with the left hand, scoop in soil to fill the pot 1/3 full.
3. Right hand holds cutting in pot while left hand fills pot with soil. The soil is smoothed level with the rim.
4. Pick up the pot with fingers of both hands around the sides, then with the thumbs, gently firm the soil on both sides of the plant; give the pot a quarter turn, and firm the soil again. Do not firm the soil close to the stem of the cutting or the roots may be pushed off the cutting!
5. Strike the bottom of the pot lightly on the bench to firm the soil.
6. Place transplanted cuttings in transfer flat.
7. Label one pot of each plant flat.

V. Observation:

LABORATORY EXERCISE

PLANTING BARE-ROOT TREES AND SHRUBS

I. Objective: Given specified tools and supplies, the student will be able to plant a bare-root shrub at the correct depth using supports to maintain an upright position.

II. Introduction:

Bare-root trees can only be successfully transplanted in the dormant state (late fall, early spring), and at times when the soil is not frozen.

Many kinds of shade trees can be successfully transplanted bare-root in sizes up to two-inch trunk diameter at breast height (4 ft.).

III. Note: Trees are transported with the branches tied upward. After the tree has been planted the twine should be removed so that the branches are restored to a natural position. Trees should be watered thoroughly once every week from April to November the first season after planting.

IV. Procedure:

1. Roots should lie covered with wet burlap or shingle tow untl shrub is actually placed in the hole.
2. Dig a hole 12 inches wider than the root spread and 6 inches deeper than shrub planting depth (depth at which it originally grew).
   - (a) Find width of root spread with yardstick.
   - (b) Find planting depth of root system.
   - (c) Add 12 inches to actual root spread and mark circle on ground surface.
   - (d) Dig to indicated width and depth. (Put soil on burlap to keep the lawn clean.)
3. Make up soil mixture of 1/3 to 1/2 peat by volume with soil removed from the hole.
4. Put about 8 inches of mixture in bottom of hole.
5. Holding the tree in proper position (at the center of the hole and at the depth at which it originally grew), add soil mixture to the hole, gently working it among the roots and firming with the fingers.
6. After filling the hole, gently firm the soil with the feet.
7. "Dish" the soil by making a 2 inch rim of soil around the shrub.
8. Drive an 8 foot stake into the soil about 6 inches from the trunk (on the windward side of the tree).

9. Fasten the tree to the stake using rubber hose and wire as shown in the picture.
10. Thoroughly water the tree by filling the dish with water to the rim. When the water has drained away, fill the dish again. Do this three or four times.

LABORATORY EXERCISE

PLANTING HARDY BULBS

I. Objective: Given specified tools and supplies, the student will be able to plant hardy flower bulbs at the correct spacing and depth.

II. Introduction:

Hardy bulbs such as tulips, daffodils, and Dutch hyacinths will do well almost anywhere if the soil drains well. They are planted in the fall for spring flowering. Care must be taken to plant the bulbs 6 inches apart in an upright position, at the correct depth. They are planted about three times as deep as the bulbs are high. The soil must be properly prepared and fertilized before planting. Once planted, the bulbs should be watered and mulched.

III. Note: If planted at the appropriate depth, these bulbs will multiply slowly and will not need to be dug, divided, and replanted more frequently than once in three years.

Daffodils should be planted in September for good root development in fall. Tulips and Dutch hyacinths should be planted in October.

IV. Procedure:

1. With the aid of the instructor, select an appropraite place to plant the bulbs.
2. Remove the soil from the area in which the bulbs are to be planted to a uniform depth of 6 inches.
3. Apply the 5-10-5 fertilizer at the rate of 4 lbs/100 sq. ft. to the bottom of the excavated area.
4. Spade the fertilizer into the soil.
5. Using the yard stick and the finger, mark the places where the bulbs are to be planted at a 6 inch spacing.
6. Put the bulbs in position, making sure the flattened part is down and the pointed part is up.
7. Carefully replace the soil without moving the bulbs out of position.
8. Thoroughly water the soil.
9. Apply 6" of straw mulch to the area.
10. Clean the area and store tools and equipment.

V. Observations:

LABORATORY EXERCISE

PLANTING ANNUAL FLOWERS

I. Objective: Given tools and supplies and annuals, the student will plant a bed of annual flowers using approved practices learned in class.

II. Introduction:

Annual flowers are frequently used in beds, planters, and mixed borders to supply color during summer months. They require well-drained soil, fertilizer low in nitrogen, and most kinds require full sun. They are planted from early April until early June depending on the last frost date for the area.

III. Note: Soil can be worked only when it is slightly moist. If it has become too dry, water it thoroughly and wait about 2 days before working the soil. Wait about 2 days after a rain before working the soil.

IV. Procedure:

1. With the help of the instructor, select an area for a flower bed, mark it with stakes, and string, and determine the square footage.
2. Calculate the number of plants needed, using a 9" spacing, with 5½" spacing from the bed edge.
3. Calculate the amount of 5-10-5 fertilizer needed, at the rate of 2 lbs. per 100 sq. ft. of bed area.
4. Estimate the amount of peat needed at the rate of one 6 cubic foot bale per 100 sq. ft. of bed area.
5. Apply estimated amounts of fertilizer and peat to the bed area.
6. Using the spading fork or garden spade, turn under the peat and fertilizer mixing it into the soil.
7. Smooth the surface of the bed, and using the yard stick, mark the positions for the plants with a trowel.
8. Carefully removing the plants from their container, plant them in the marked positions about ¼' deeper than they originally grew.
9. Thoroughly water the bed.
10. Remove all tools, equipment, and supplies from the area and store them. Dispose of all trash.

V. Observations:

LABORATORY EXERCISE

REPOTTING PLANTS

I. Objective: Given a recommended soil mixture, several potted plants and containers more than 1" greater in diameter than those in which the plants are growing, the student will remove the plant from the old pot and will replant it in a larger sized pot.

II. Introduction:

Customers sometimes purchase a plant and ask to have it replanted into a different container. Once in a while, a customer may bring in a plant that is too large for its container and ask that it be planted in a larger one.

III. Procedure:

1. Thirty minutes before repotting is to be done, thoroughly water the plants to be repotted. This assures that the soil ball will hold together when the pot is removed.
2. Place several pieces of broken pot over the drain hole in the selected container. They should form a hump to keep the soil from plugging the drain hole.
3. Add enough steam-treated soil mixture so that the soil surface of the original soil ball will be positioned ½ inch below the pot rim (allow for about ¼" settling).
4. To remove the plant from the pot, place one hand on the surface, palm downward, with the stem of the plant between the fingers. Using both hands, turn the plant upside down and give the pot rim a sharp rap on a table edge. The soil ball should fall into your palm. Set aside the old pot.
5. Turn the plant right side up and place it in the center of the prepared new pot. Press it gently into the new soil. If the old soil ball surface is higher than ½ inch below the soil surface, lift out the plant, remove some soil, and try it agin. If the plant was too deep in the original trial, remove it, add some soil, and check again.
6. Once the plant is in proper position, add soil to fill the open space between the soil ball and the pot wall. Firm the soil with the fingers, adding more if needed so that the fill is ½ below the pot rim.
7. Fill the space at the top of the pot with water. When it has disappeared, fill it a second time. If water has not begun to drain from the hole, fill it a third time.

8. Repeat this procedure with additional plants provided by your instructor.
9. Put the repotted plants in a place designated by your instructor. Clean the work area, putting all equipment and supplies in their storage place.

LABORATORY EXERCISE

PLANTING A BALLED AND BURLAPPED SHRUB

I. Objective: Given the materials indicated below, the student will be able to plant a balled and burlapped shrub in an upright position and at the depth at which it originally grew.

II. Introductin:

Nearly all evergreens are balled and burlapped for transplanting. These plants are handled this way because they are not likely to live if moved as bare-root plants. Certain deciduous plants, such as flowering dogwoods and magnolias, are also transplanted as B & B shrubs.

Care must be taken in handling these plants. If the soil ball cracks, the resulting root damage may kill the plant.

III. Note: These shrubs must be watered thoroughly once each week from April through October the first season after planting. (At each watering the "dish" should be filled 2 or 3 times.) Evergreens require a very heavy watering in late fall, as well as protection from sunlight and strong winds the first winter after planting.

IV. Procedure:

1. Dig a hole large enough to give a 6 to 8 inch clearance all around the ball and 6 inches deeper than the depth of original planting. (Put the soil on burlap to keep the lawn clean.)
2. Make up a soil mixture by mixing 1/3 to 1/2 peat with soil removed from the hole. (Mix on burlap.)
3. Put about 8 inches of this mixture in the bottom of the hole.
4. Set the plant in the hole with the burlap still around the ball of earth, adjust so it is about 1 inch higher than the depth it originally grew. (The plant will settle a little when watered.)
5. Cut the string and fold back the burlap to about 1/3 of the height of the soil ball.
6. Add soil mixture to half the depth of the hole, firming it with the feet.
7. Add water to fill the hole to the rim, and allow it to drain away.
8. Finish filling the hole to the level of the surrounding soil surface, and "dish" the soil by making a 2-inch mound of soil at the rim of the filled area.

9. Fill the saucer shaped surface to the rim with water. If the branches of the plant were held upright with twine, cut the twine so the branches will go back to a natural position.

LABORATORY EXERCISE

PLANTING CONTAINER-GROWN TREES AND SHRUBS

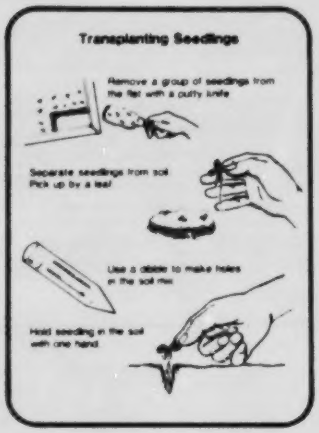
I. Objective: Given a container grown plant and equipment plant the container grown plant in the landscape.

II. Procedure:

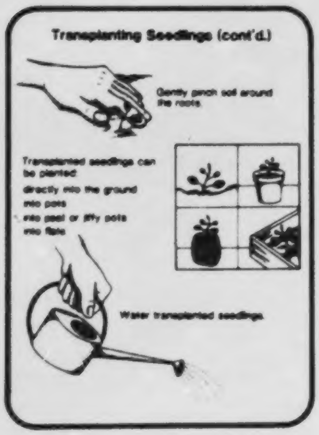
1. Remove the plant from its container.
2. Use a knife to make cuts in the root ball.
3. Make several cuts on the sides and the bottom of the root ball.
4. This helps roots to grow out of the root ball.
5. Dig the hole 10 or 12 inches wider than the root ball.
6. The hole should be as deep as the root ball.
7. Add the peat moss to the soil that will be used to plant the shrub or tree. Mix it well with the soil.
8. Put the plant in the hole.
9. Turn the plant so that it looks good and is setting straight in the hole.
10. The top of the root ball and the soil level should be the same.
11. Put the soil mix around the plant.
12. Pack the soil down so that it is firm around the plant.
13. Use the rest of the soil to build a dish around the plant.
14. This will help hold water to keep the soil moist.
15. Stake large trees and shrubs
16. Water the plant well when you are all finished.
17. Water each week when there is little rainfall.

OBSERVATIONS:

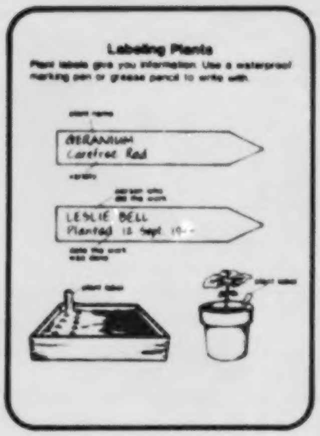
PLANT PROPAGATION


Transplanting Seedlings
Remove a group of seedlings from the flat with a putty knife
Separate seedlings from soil
Pick up by a leaf
Use a dibble to make holes in the soil mix
Hold seedling in the soil with one hand

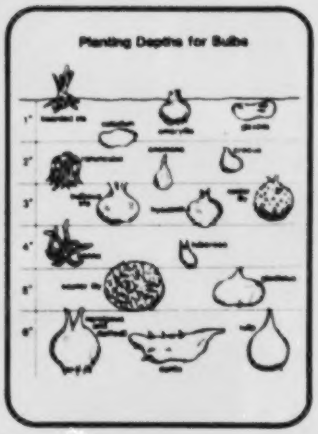
12. Transplanting seedlings is a process. When the dicot seedling has its first pair of true leaves the seedling is ready for transplanting. "Hardening-off" should be practiced, which involves the reducing of temperature, and the limiting of moisture and nutrients in preparation of transplanting. This process reduces transplanting shock. Remove a small group of seedlings from the seed flat at a time. This prevents over handling of the seedlings and does not allow them to dry out while waiting to be transplanted. Before transplanting, seedlings should be sized into two flats to ensure an even growing and developing flat. Pick up the seedling by its true leaves and not the stem. Root prune the seedling if necessary before you place the seedling in the dibbled hole.


Transplanting Seedlings (cont'd.)
Gently pinch soil around the roots
Transplanted seedlings can be planted
directly into the ground
into pots
into peat or jiffy pots
into flats
Water transplanted seedlings.

13. Make sure the soil is firm around the seedling. Many garden seeds are planted directly in the soil, then transplanted to another location in the garden. Seedlings can be transplanted into almost any container that has proper drainage. Make sure the newly transplanted seedlings are watered immediately.


Labeling Plants
Plant labels give you information. Use a waterproof marking pen or grease pencil to write with.
GERANIUM
Carefree Red
LESLIE BELL
Planted 15 Sept 19--

14. Pots, flats, or rows in the propagation bench, nursery stock, or garden center need to have their plants identified by a plant label. When making a label for identifying plant material, always use a waterproof pen or pencil because ink will come off the label after several waterings. The plant name, variety, date, and what work was completed is placed on the label. Commonly, in the school setting or where several people in one business are doing the same activity, the workers name will also appear in the label. When multiple containers are involved a system can be developed for labeling one container; the rest of the containers are arranged in the row or bed behind, in the front of, or to the left or right of the label. This eliminates duplicate labeling. However many propagators label all plants.


Planting Depths for Bulbs
1"
2"
3"
4"
5"
6"

15. Seventeen of the most common "bulbs" are identified and the depth at which they are to be planted in the garden. The term "bulb" is used here to include corms, tubers, rhizomes and other botanical structures.

SAMPLE TEST QUESTIONS

1. What are bulb pans?

2. What is panning?

3. What are azalea pots?

4. What are rose pots?

5. What are jiffy pots?

6. What is a standard pot?

7. What is a market pack?

8. What is pricking off?

9. Why does one root prune plants? Identify three examples.

10. Describe double potting.

11. What are the characteristics of an ideal container?

12. When should one transplant cuttings?

13. What are the steps to be followed in these situations:

    a. Transplanting seedlings:

    b. Transplanting balled and burlapped lilac:

    c. Transplanting bareroot willow:

    d. Transplanting peat balled tree:

    e. Transplanting tulip bulbs in a pot:

14. What is the function of a "lip" on a newly transplanted shrub or tree?

15. Why double plant house plants?

16. Describe six systems of market packing annual flowers.

17. Describe the seedling when its time for transplanting?

18. Define hardening:

19. List the steps to follow after transplanting:

20. State the steps in the process by which plants are hardened.

21. What are the rules to follow when transplanting?

22. Name four considerations in the care of seedlings before transplanting:

23. Why are cuttings graded for size before being planted?

24. Why are some cuttings placed at an angle when planted?

25. Why can some plants be planted bareroot?

26. How much of the plant should be pruned out when planting bareroot?

27. What is the difference between a bareroot rose and a packaged rose?

28. Why should thin barked trees not be transplanted in the fall?

29. Identify the characteristics of back fill going in to a hole with a balled and burlapped tree?

30. Identify the ideal "hole" for planting a balled and burlapped plant.

31. At what depth should one plant nursery stock?

32. What has happened when a soil ball cracks?

33. Why should burlap not be removed when planting a tree or shrub?

34. Why must nursery liners be watered within 30 minutes of planting?

35. What is a callus?

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: IDENTIFYING AND USING STRUCTURES USED IN THE PRODUCTION OF PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshmen or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the fall semester. It is suggested that the students build a cold frame or some other structure while studying this problem area. If building a project is not appropriate maintenance of existing school structures may be appropriate.

The estimated instructional time for this problem area is 5 to 7 days. Depending on how far the teacher wishes to go in developing use of horticultural structure skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, involved in other activity exercises, the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this are for reference or modification as instructors adapt this material to their local situation.

CREDIT SOURCES:

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The teacher's guide and test questions were developed by Jim Ethridge. Transparency masters and the transparency discussion guide were prepared by the Vocational Agricultural Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Growing and managing horticultural crops

II. Problem area: Identifying and using horticultural structures used in the production of plants

III. Objectives: At the close of this problem area students will be able to--

1. Distinguish between and know major functions of growing structures used to produce horticultural crops.
2. List five basic shapes of commercial greenhouses and advantages and disadvantages of each.
3. Identify structure coverings and when and where each might successfully be utilized.
4. Identify accessory equipment (benches, beds, mist systems).
5. Identify related greenhouse structures.
6. To compare the advantages and disadvantages of the various materials used in constructing greenhouses.
7. To explain how greenhouses are heated and cooled.

IV. Suggested interest approaches:

1. Lead into a discussion of progation structures by asking students what type of structures they have seen or worked in. Ask them to describe the structures.
2. Show transparencies of propagation structure types and show film strips on greenhouse designs.
3. Take class on a propagation structure tour to observe the current production structures available in the area.
4. Show actual pieces of greenhouse coverings currently available.
5. Build a display showing various types of greenhouses and how the home gardener can make use of them.
6. Tour several local horticultural businesses which grow crops and have students identify the materials used on a field trip worksheet.
7. Collect and display the various types of construction materials used in greenhouses and label them as to the types of structures each is used for.

V. Anticipated problems and concerns of students:

1. What are the different types of plant-growing structures used in horticulture?
2. What types of materials are available for covering a greenhouse?
3. How are greenhouses cooled?
4. How ar greenhouses heated?
5. What are cold frames used for?
6. Why do horticulturists use cold storage facilities?
7. What should be found in a head house?
8. What kind of heating systems are used in growing structures?
9. What kind of cooling system are used in growing structures?

VI. Suggested learning activities and experiences:

1. Have students identify the types of structures they have viewed while visiting plant shops. Have the students relate their experiences.
2. Show greenhouse design slidefilms and have students record tentative answers to the problems and concerns identified by the class or teacher.
3. Have the students read commercial catalogs and collect information concerning problems and concerns identified by the class or teacher.
4. Show transparencies on "Growth Structures Used in Horticulture".
5. Use the field trip to identify the difference structures.
6. Compare advantages and disadvantages of different greenhouses, benches, cooling equipment and heating equipment.
7. Prepare a series of cards giving a general description of a structure and ask the student to identify the structure.
8. Have the students make a collection of pictures of greenhouses used throughout the world.

VII. Application procedures:

1. The main purpose of this problem area is to teach information and develop the ability of the student to recognize environmental structures and to work with and in them.

2. The application phase should be emphasized in the Problem Area on Operation of Greenhouse Equipment.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test using Sample Test Questions as possible test items.

2. Collect and grade written work.

3. Observe student performance in the greenhouse while working on the structure (if available).

4. Observe performance in working in and on structures used in horticulture.

IX. References and aids:

1. The Greenhouse Environment, The Effect of Environmental Factors on Flower Crops by John Mastalerz, John Wiley and Sons, New York, Read Chapter 1, pp. 3-8.

2. Greenhouse Equipment Catalogs.

3. 50 Laboratory Exercises for Vocational Ornamental Horticulture, Compiled by Paul Hemp, The Interstate Printers and Publishers, Danville, Illinois.

   A. "Constructing a Hot Bed" p. 141.
   B. "Building a Portable Lath Screen" p. 145.

4. Transparencies and Transparency Discussion Guide.

5. Sample Test Questions

6. Plant Propagation, Principles and Practices, Hartman and Kester, 3rd Edition Prentice Hall, Inc. Publishers. Read Chapter 2, pp. 17 to 25.

7. Ball Red Book, 13th edition. Read Chapter 4, pp. 58 to 68.

8. Sunset Basic Gardening Illustrated, Lane Books, Menlo Park, CA. Read pp. 74 to 75.

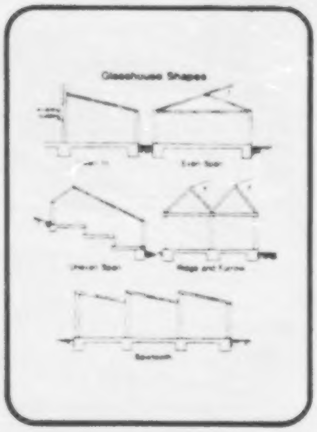
9. Vocational Agriculture Service Slidefilm:

   A. #680 Greenhouses Uses and Designs"

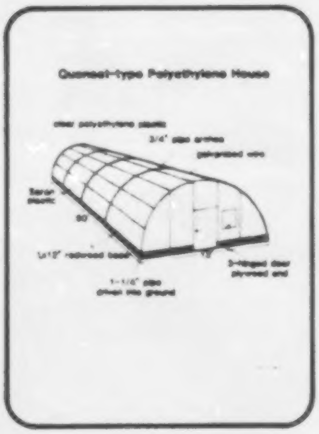
TRANSPARENCY DISCUSSION GUIDE

ENVIRONMENTAL FACTORS

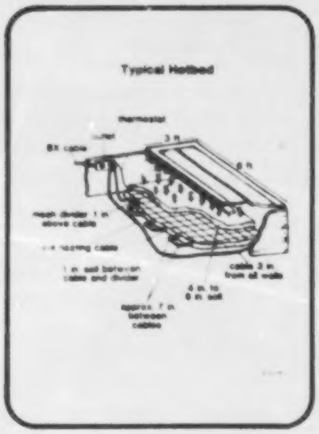
Structures


Glasshouse Shapes
Lean-To
Even Span
Uneven Span
Ridge and Furrow
Sawtooth

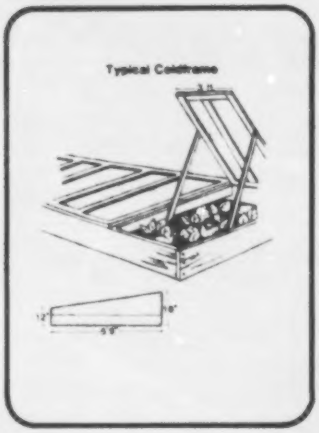
1. There are three basic types of greenhouses: (1) the lean-to greenhouse, (2) the detached or single span greenhouse, and (3) the ridge and furrow greenhouse. The roof of a lean-to usually slopes in one direction. Relatively few lean-to greenhouses are used commercially. The detached greenhouse stands independently and may be connected to other greenhouses by a corridor, or attached at one end to a building. In an even span greenhouse the rafters are of equal length. In an uneven span greenhouse, the rafters of one roof slope are longer than the rafters of the other roof slope. The floor of the unven span greenhouse can be sloped or level. A ridge and furrow greenhouse consists of several greenhouses connected at the eves. A greenhouse is a structure covered with transparent material and therefore uses the sun to grow plants. The greenhouse may or may not have a vent.


Quonset-type Polyethylene House
clear polyethylene plastic
3/4" pipe arches
galvanized wire
Saran plastic
90
2"x12" redwood base
1-1/4" pipe driven into ground
hinged door plywood end

2. The quonset-type greenhouse is today the most popular type of commercial greenhouse. The construction of a quonset-type greenhouse tends to be less expensive than rigid construction greenhouses of the same square footage. Growers will usually agree that one can grow a similar quality crop in either type of greenhouse. The costs of recovering a greenhouse in the long run (ten to twenty years) is about the same as glass. (The quonset is usually covered with a single or double sheet of polyethelene insuring a greater build up of humidity in the quonset greenhouse over rigid construction greenhouses.) Widths of quonset greenhouses usually begin at 12 feet and my be as large as 30 feet across. A 100-foot length is not uncommon. Saran may be added to the greenhouse for shade. The bases of quonset greenhouses vary in the size and quality of wood used.


Typical Hotbed
thermostat
outlet
3 ft
6 ft
mesh divider 1 in above cable
heating cable
1 in soil between cable and divider
cable 3 in from all walls
4 in to 6 in soil
approx. 7 in between cables

3. The typical hotbed is a sloped box-like structure fitted with a removable glass sash. It has the auxiliary heat supply which is usually electric. The front height on the hot bed should be at least six inches above the soil level giving the seedlings room to grow. The sides should be buried at least one foot below ground allowing for the drainage layers. The hot bed allows plant growth to begin earlier in the spring, gives bottom heat for the rooting of cuttings, and provides for the overwintering of tender perennials. Heating cables are available sheathed in lead or vinyl. The lead coated cable is usually more expensive yet they last longer. Thirty feet of heating cable (180 watts at 115 volts) is sufficient for one sash of hotbed three feet by six feet.


Typical Coldframe
3 ft
12"
6"

4. The typical cold frame is a hotbed without heat. Plants grown in cold frames are maintained from outside the structure and are commonly located on the south side of a building. Generally speaking, three feet by six feet is a practical minimum; if any smaller, the frame cannot hold enough heat for cold nights. The slope of the roof is one inch for each foot of width. The purpose of the slope is to allow sufficient light to enter the frame. The frame can be hinged for convenience and temperature control. Drainage should be provided for so water does not collect on the sash.

SAMPLE TEST QUESTIONS AND TEACHERS KEY STRUCTURES

1. What alternatives are available for ventilation in greenhouse growing structures?

    a. Roof and side openings.
    b. Exhaust fans.
    c. Through perforated convention tubes.
    d. Roof shading.
    e. Shade cloth.
    f. Evaporative cooling.
    g. High pressure mist.

2. What alternatives are available for growing structure heating?

    a. Steam.
    b. Hot water.
    c. Forced hot air.
    d. Solar radiant energy.

3. What is a sashhouse?

4. Why does a propagation house need shade cloth?

5. What is a lath frame?

6. What is a cold frame?

7. What is a nursery bed?

8. What is a lath house?

9. What is a wintering house?

10. What are the principal uses of forcing hills?

11. What are the advantages of hot beds over cold frames?

12. What are the methods of heating hot beds?

13. What are the two most often used materials for greenhouse coverings?

14. Why is the fall the best time of year for repairing or replacing slipped or broken glass?

15. What properties should an ideal greenhouse plastic possess?

16. What are some of the advantages and disadvantages of polyethylene and vinal?

17. What are the characteristics of a "good" greenhouse bench?

18. What is the best height of a pot plant bench?

19. What should be the minimum depth of cut flowers benches?

20. What are the advantages and disadvantages of glass, fiberglass, and polyethylene?

21. Define:

    a. Greenhouse:

    b. Greenhouse range:

    c. Shade house:

    d. Cold frame:

e. Hot bed:

f. Glazing:

g. Wintering house:

h. Polyethylene:

i. Fiberglass:

j. Convention tube:

k. Raised bed:

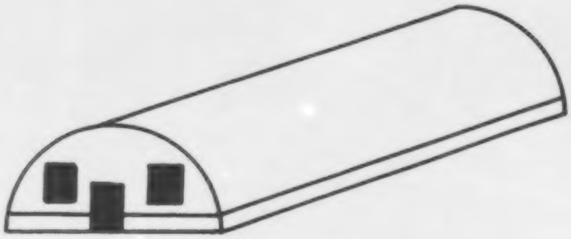
l. Peninsula bench arrangement:

m. Head house:

n. Glass sash:

22. Label the parts from the list below, that exist on our greenhouse only.

*Side curtain wall
*Side wall
*Roof
*Eave
*Ridge vents
*Gable ends
*End wall
*End curtain wall
*Footings



23. What is the major difference between a coldframe and a hot bed?

24. What is the major use of cold frame or hot bed?

25. List five advantages of an overhead mist system:

a.

b.

c.

d.

e.

26. Identify four types of coverings used on propagation structures.

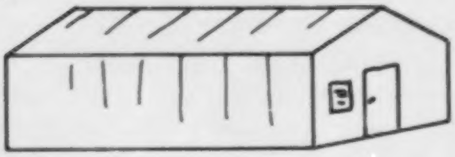
a.

b.

c.

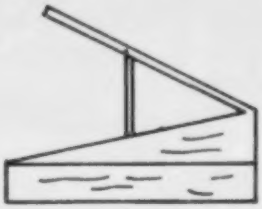
d.

27. Label each of the following structures and list the functions of each.



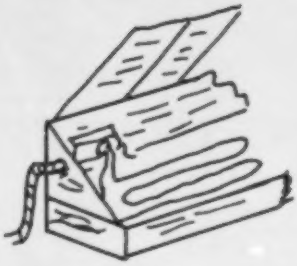
a. ______________

b.



a. ______________

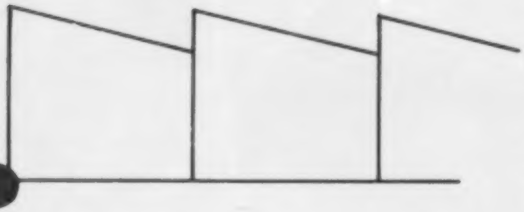
b.



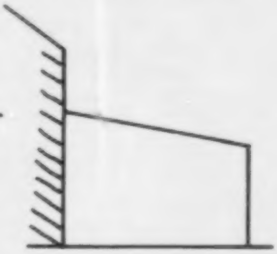
a. ______________

b.

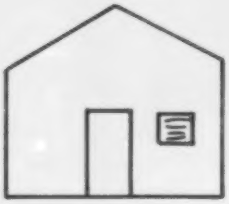
28. Identify the following greenhouse shapes.



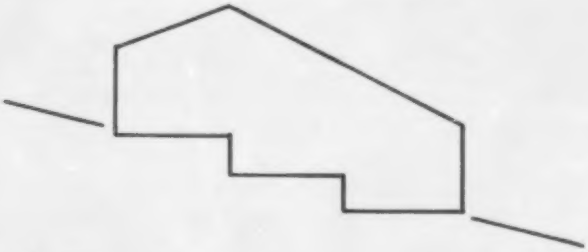
a. ______________



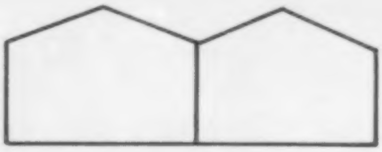
b. ______________



c. ______________



d. ______________



e. ______________

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: UNDERSTANDING AND CONTROLLING TEMPERATURES AROUND PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshman or beginning students in a horticulture or agriculture occupations program. The recommended time for teaching this problem area is during the fall semester.

The estimated instructional time for this problem area is three to five days, depending on how far the teacher wishes to go in developing skills in this area at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instructional can be two days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this problem area are for reference or modification as instructors adapt this material to their local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide, student worksheet, exercises, and test questions were developed by Jim Ethridge. Transparency masters and the transparency discussion guide were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Growing and managing horticultural crops

II. Problem area: understanding and controlling temperature around plants

III. Objectives: At the close of this problem area students will be able to--

1. Identify physiological processes affected by temperature.
2. Control temperature in forcing flowering of bulbs and other plants and plant parts.
3. Explain how optimum temperature changes with the size and development of the plants.
4. Use the vocabulary needed to understand temperature and how it regulates plants.

IV. Suggested interest approaches:

1. Take soil temperature readings of two similar landscaped beds. Compare and discuss the findings.
2. Take air temperature and soil temperature of a greenhouse crop. Compare and discuss the findings.
3. Take soil temperature of a north side building, two feet away and the south side. Compare and discuss the findings.
4. Take a field trip to a wholesale florist and identify how cut flowers and foliages are stored at different temperatures - why. Also, examine the boxes of flowers and discuss why ice is used in packing.
5. Take a field trip to a wholesale storage of bare root nursery stock and note temperature of storage of crop. Identify variations of cool temperature storage. Also note similar findings in bulb storage.
6. Select two plants of the same genus - One hardy to this area the second not hardy and discuss hardiness.
7. Spray a fine mist in on dry hot surface - watch the material collect on the surface then vaporize - discuss this with the students and problems with chemical application when too hot.

V. Anticipated problems and concerns of students:

1. How does temperature affect growth of plants?
    a. Roots.
    b. Stems.
    c. Leaves.
    d. Flowers.
    e. Bulbs - Tubers.
    f. Seeds.
2. Why are cut flowers cooled immediately after harvest?
3. When are cut flowers harvested?
4. How does water temperature affect plants?
5. How does soil temperature affect plants?
6. How are diseases affected by temperature?
7. How does temperature affect the application of chemicals?
8. What is dormancy? And how does temperature affect it?
9. How does temperature affect:
    a. Annuals?
    b. Biennials - What is bolting?
    c. Perennials?
10. What are short day, long day, and day neutral plants?
11. How can temperature be controlled in growing structures?
12. Why do nurserymen cool off plants before transplanting?
13. Why do we plant "balled and burlapped" stock in the spring and fall?
14. Why do some vegetables fail to produce a crop?
15. What are the ways in which temperature can be controlled: in the home, in the greenhouse or in the home landscape?

VI. Suggested learning activities and experiences:

1. Obtain two plants. Grow one of the plants at its optimum temperature nighttime, and 10-15 degrees cooler during the day. Place the other plant in another location so its day and night temperature is 10 degrees F. over its optimum night all the time. As the plant matures observe the plant.
2. Cut some flowers for a garden in early morning, at noon and in early evening - Which ones last longer in water and why?
3. Force some tulip bulbs. Plant one pot and begin growing it in the greenhouse. The second and third pot give the proper chilling time. After chilling place pot two in a 70 degree night environment and pot 3 in a 55 degree F. night environment -observe the results.
4. Grow African violets, one group with optimum inverse thermoperiodicity and the second group with thermoperiodicity - Compare the results.
5. Germinate some common vegetable seeds for transplanting one flat. Keep a constant temperature day and night until transplanting. The second flat use durinal variation and drop the growing temperature back about 10 degrees F. after germination - observe the results.
6. Germinate some seeds using the seed (1) optimum, (2) critical high temperature, (3) critical low temperature and observe the results.
7. Observe the flower of lavender mums. After the blooms begin to open hold on flower at 70-80 degree day temperature and the second at 55-60 degree F. Compare your results. The same can be done on white varieties.
8. Have students read VAS Unit 5019 and VAS Unit 5017 and record tentative answers to the problems and concerns identified by the class or teacher.

VII. Application procedures:

1. The main purpose of this problem area are to teach information about toward plant growth and development as affected by temperature.
2. The application phase should be emphasized while growing horticultural crops, care for plants in the home, landscaping school grounds, and making decisions as to what is the best way to manage the given situation in respect to temperature control.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test using Sample Test Questions as possible test items.
2. Evaluate learning activities and temperatures records and results by students.
3. Evaluate solutions made by students concerning temperature problems they encounter when raising plants in their supervised experience programs.

IX. References and aids:

1. The Greenhouse Environment, The Effect of Environmental Factors on Flower Crops, by John Mastalerz, John Wiley and Sons, New York, Read Chapter 3 "Temperature", pp. 97 to 154.
2. Laboratory Exercises on:
   - A. "Effect of Temperature on Vegetative Growth"
   - B. "Effect of Temperature on the Flowering of Herbaceous Plants"
3. Student Worksheet on
   - A. "Temperature Requirements for Plants"
4. Sample Test Questions and Teachers Key
5. Vocational Agriculture Service Units:
   - A. #5019 "Care of Flowering Plants in the Home", p. 3.
   - B. #5007 "Growing Plants Indoors", p. 4.
6. Plant Propagation, Principles and Practices, Hartman and Kester, 3rd Edition, Prentice Hall, Inc. Publishers. Read pp. 34, 200 to 105, 120, 122, 134, 150, 157, 160, 167, 254, 329.

STUDENT WORKSHEET

TEMPERATURE REQUIREMENTS FOR PLANTS

I. Objective:

1. Given a group of plants, determine the temperature requirements of each plant.

II. Introduction:

1. Temperature Levels:

Cold: "C", 40-45°F (5-7°C) at night, rising to about 55°F to 60°F (13°-15°C) on a sunny day, with air; 50°F (10°C) in cloudy weather.

Intermediate: "I", 50-55°F (10-13°C) at night, rising to 70°F (21°C) on a sunny day, or somewhat higher, with air; 60°F (15°C) if cloudy, before opening ventilators.

Warm: "S", 62-65°F (16-18°C) at night; can rise to 80 or 85°F (27-30°C) in the daytime. Plants that take a rest or dormancy period, should be kept a few degrees cooler during this time until active growth is to begin again.

III. Procedure:

1. Identify your plant with a plant label; including the common name of the plant as well as the scientific name.
2. On the plant label put one of the three letters (C, I, or S) to identify the temperature requirements for placement in the proper growing environment.

LABORATORY EXERCISE

EFFECT OF TEMPERATURE ON VEGETATIVE GROWTH

I. Introduction:

When horticulturists speak of a plant as a 50 degree or 60 degree plant, they mean that the plant will grow satisfactorily when the night temperature is 50 degrees or 60 degrees F. Under normal conditions in a greenhouse, the day temperature will be raised five degrees F. on a cloudy day and ten degrees F. on a sunny day. This fluctuation is necessary in order to meet various requirements of plants caused by varying the transpiration rates. Plant processes must speed up when the temperature is higher and the light is brighter. As an example, a 50 degree plant will grow best under the following conditions:

1. 50 degrees F.--night temperature.
2. 55 degrees F.--cloudy day temperature.
3. 60 degrees F.--sunny day temperature.

The purpose of this demonstration is not necessarily to determine the limits of maximum, minimum, and optimum temperatures, but rather to help the student understand that plants vary in their temperature requirements for maximum rate of growth.

II. Objectives:

1. To develop an understanding of the influence of temperature on vegetative growth of herbaceous flowering plants.

2. To develop the ability to control temperatures in the greenhouse according to the needs of the plants begin grown.

3. To develop a knowledge of the temperature requirements of some plants.

III. Material:

1. Six plants of any two of the following:

   a. Antirrhinum (snapdragon)
   b. Coleus
   c. Delphinium
   d. Gypsophilia (baby's breath)
   e. Impatiens
   f. Primula (primrose)
   g. Tagetes (marigold)

2. A supply of suitable sized pots for the plants being grown.

3. Planting medium.

4. A cool (50-60 degrees F.) greenhouse or working area and a warm (60-75 degrees F.) greenhouse or growing area.

5. Growing chamber if available.

IV. Procedure:

1. Select and pot six plants of the same species that are of comparable size two weeks before the time they are to be used. Six plants, each of a fifty degree F. and a sixty degree F. species, may be planted to demonstrate the adverse as well as the favorable temperatures for both kinds.

   A partial list of plants requiring different temperatures follows:

Fifty degree plants	Sixty degree plants
Antirrhinium	Coleus
Delphinium	Impatiens
Gypsophila	Tagetes
Primula	

2. Place three plants of one species in a warm growing area and three matched plants of the same species in a cool growing area.

3. Care for the plants in each area in the same manner, allowing only for the difference in watering required because of the different temperatures.

4. At intervals of ten days, record the differences noted in growth of all plants grown by the entire class. At the same time compare and record the differences in growth, color of foliage, and flower development, or any other factor pertaining to each individual group of plants.

V. Application:

Some plants grow better at a certain temperature while others will grow best at a different temperature. A grower should be aware of these different requirements. He should also be aware that within the same species there may be temperature differences required among cultivars. For these reasons, it is necessary that he be familiar with not only the different temperature requirements, but also that he know how to adjust temperatures in the greenhouse as needed.

One of the best ways ideally to observe rigid temperature control is through the use of a growth chamber. With such units there can be no question as to the causes and results of differences in temperature and its effects on plants. Growth chambers may be purchased from different commercial firms, but often the price is prohibitive for a school or for a department.

VI. Observations:

LABORATORY EXERCISE

EFFECT OF TEMPERATURE ON THE FLOWERING OF HERBACEOUS PLANTS

I. Objectives:

1. To develop an understanding of the importance of maintaining a proper temperature before and during the reproductive cycle of the plants.
2. To develop the ability to control greenhouse temperatures.

II. Materials:

1. Potted cuttings or seedling plants.
2. Two greenhouses or growth chambers, so that two different temperatures may be maintained (or areas of a greenhouse).
3. A method of temperature control and ventilation if growth chambers are not to be used. This may include electric heating cable, cheesecloth or saran cloth for shading, and thermostats.
4. Appropriate containers in which to grow the plants, such as pots or benches.

III. Procedure:

1. Select 10 to 20 plants and grow them uniformly in four-inch pots or benches at 60° F. through the vegetative period (long photoperiod--16 hours of daylight).
2. In order to observe the effects of temperature differences, at least two different and separate demonstrations should be maintained.
3. At the beginning of the reproductive period (short photo period--9 hours of daylight), grow the first group of plants at 45°-50° F. night temperature and the second group of plants at 60°-65° F. night temperature.
4. Allow the day temperatures to rise 5° to 10° F. above the night temperature.
5. In order to control temperatures, it is advisable to conduct this demonstration only during the late fall or winter months.

6. Care for the plants in both temperature groups in the same manner in regard to water, fertilizer, and light. Some allowance will be necessary for the higher temperature. It may be found that the plants in this group will require more water than the others.

7. Observe and record differences in height, time required for flower, and difference in flower characteristics between the two groups. Make analysis of the differences and decide which conditions are the best for growing chrysanthemums. A sheet for recording this information may be made up in the form of a chart using the following column headings:

Temperature group__________
Date started_______________
Height at beginning_________
Height at end______________

Artificial light used_________
a--Beginning___________
b--Ending______________
Date of bud coloring_________
Date of bud opening_________
Height at end oi period______

Remarks on flower characteristics (size, color, number, petal stiffness, flower quality, and others.______________________________________
____
____
____

IV. Application:

If the proper temperature is not used, flower buds may develop slowly or may not form, even when the plants are grown under proper reproductive photoperiod. For many species, the best night temperature is 60° F. Control of temperature is therefore extremely important after the beginning of short days and through the period of bud formation. In chrysanthemums, flower bud formation is dependent on temperature and short days. Such plants are said to be thermophotoperiodic--that is, they require both optimum temperature and appropriate length of day (60°-65° F. and 9 hours) for flower bud formation.

With some species, the temperature can be reduced to 50° F. when the color of the petals is visible, and this is done to improve flower shape and petal stiffness. Conversely, flower buds will form, but not develop when the temperatures is 90° F. or higher for periods of a week or more. The resulting delay in flower bud development to the flowering stage is referred to as heat delay.

All varieties within a species do not respond to temperature in the same manner. Whereas most varieties will develop flower buds faster when the night temperature is 60° F., some varieties will form buds at 55° F., but at a slower rate. There are other varieties that will form buds from 70°-80° F., but again, at a slower rate than those which form at 60° F.

For this reason, it is necessary to not only be aware of temperature requirements, but also to be aware of the variety classification which is a grouping of varieties made according to the length of time required for flower buds to develop after the beginning of short days. These are called "week groups." Most greenhouse cultivars are in the ten or eleven-week group, while garden chrysanthemums are in the eight or nine-week groups.

IV. Observations:

SAMPLE TEST QUESTIONS AND TEACHERS KEY ON TEMPERATURE

True False Section

T The postharvest life of cut flowers is closely related to temperatures at which they are held after removal from the plant.

T Crushed ice has no cooling effect if flowers were packed warm.

T Watering plants with water temperature cooler than air temperature will take the soil several hours to recover to the soil temperature before watering.

T Watering plants with water temperature warmer than air temperature will take the soil only 10 minutes to recover to the soil temperature before watering.

T Root development of a lawn as well as other crops is best when soil temperature is between 50-60 degrees F.

T Temperature has a direct control over disease organisms.

T The uptake of iron by Gardenias is controlled by soil temperature.

F Low temperature generally does not affect dormancy in seeds.

T Temperature has little or no effect on photosynthesis from 59 to 86 degrees F. (air temperature).

T Thermoperiodicity is the response to diurnal tempervariations (lower night temperature than day temperature).

F African violet is an example of a plant needing thermoperiodicity.

T Temperature requirements of a plant usually decrease as the plant increases with size and age.

F Day temperature has a great deal of effect on internodes.

T The control of temperature in a greenhouse is a common way to "time" the crop.

T Optimum temperature for flower initiation is probably not the optimum temperature for flower development.

T High temperature immediately after vernalization may devernalize the plants.

T Bolting is the flowering during one growing season as a result of cold temperatures.

F Gibberellic acid cannot substitute for cold requirements.

T Ring spot is actually not a disease organism but a physiological characteristic when leaf temperature is about 30 degrees F. warmer tha water temperature.

1. Why do landscapers generally recommend balled and burlapped planting of trees in spring and fall?

2. How does temperature affect photosynthesis?

3. How does temperature affect:

   a. Length of cuttings?

   b. Size of flowers?

   c. Timing of flowering?

   d. Color of flowers?

   e. Cuttings produced per plant?

4. Discuss how optimum temperature changes with a plant's age or size.

   a. At germination.

   b. After germination.

c. At hardening off.

d. At transplanting.

e. During vegetative growth.

f. At flower initiation.

g. At flower development.

h. At flower elongation.

i. At harvest time.

j. At storage.

5. Why do optimum day temperature and night temperature differ?

6. Define: Thermoperiodicity -

   Inverse thermoperiodicity -

   Optimum night temperature -

7. Why might one consider growing their plants at a less than optimum night temperature?

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: UNDERSTANDING AND CONTROLLING LIGHT AROUND PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area is designed to use with freshman or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the Fall semester. The teacher is encouraged to demonstrate by example a large variety of effects light has on plants.

The estimated instructional time for this problem is 3 to 5 days depending on how far the teacher wishes to go in developing light control skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instructional period can be 2 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this area are for reference or modification as instructors adapt this material area to their local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide, laboratory exercises, and test questions were developed by Jim Ethridge. Transparency masters and the transparency discussion guide were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provied by the Metropolitan Core Curriculum Pilot Test Teachers.

TEACHERS' GUIDE

I. Unit: Growing and managing horticultural crops

II. Problem Area: understanding and controlling light around plants

III. Objectives: At the completion of this unit students will be able to--

1. Determine lighting requirements for a plant's successful growth.
2. Identify different types of light bulbs and the advantages and disadvantages of each as they pertain to growth of plants.
3. Identify how light quality, quantity and intensity affect diseases, and germination.
4. Demonstrate use of control devices for light requirements for flower forcing.
5. Describe light's role in photosynthesis and etiolation.
6. Apply and remove saran.
7. Apply and remove black cloth.
8. Apply and remove shading compound.
9. Describe optimum light conditions relative to a specific plant's requirements.
10. Prescribe practices for the improvement of plant growth adversely affected by light.

IV. Interest approaches:

1. Lead into a discussion of lighting by asking the students what type of lighting they have observed in a growing structure, or what background they have as to how light affects growing?
2. Put a plant into a dark location (high light) plant and discuss what happened. Do the same thing for a low light plant.
3. Bring in turf from the north side of a building with mildew and have them discover how low light encourages disease. The use of other plant materials is also desirable.

4. Grow some bean seedlings and after break through from the soil, cover one with a milk container for 5 days and show what happened afterwards when compared to some not covered.

5. Show transparencies of how light effects the photosynthesis cycle.

6. Develop demonstrations on photoperidism.

7. Develop demonstrations on phototropism.

8. Develop demontrations on geotropism

9. Demonstrate cyclic lighting.

10. Demonstrate setting up a time clock for lighting.

11. Demonstrate shade on improved flower color.

12. Demonstrate etiolalior by displaying plants that have received low light requirements and those that have received proper light requirements.

V. Problems and concerns of students:

1. Why place plants in a lath house?

2. How does light affect germination?

3. What artificial lighting sources exist?

4. How is light controlled in the commercial greenhouse?

5. How does light affect rootings of cuttings?

6. How does one identify a plant receiving too much or too little light?

7. How does light affect chemicals we apply to plants?

8. When does light affect the growth of roots?

9. How does light affect branching of woody and herbaceous stems?

10. How is flowering, flower quality and number affected by lighting?

11. How does light interact with other environmental conditions?

12. How can light be measured?

VI. Suggested learning activities and experiences:

1. In the fall, grow a bench crop (snap dragon, stocks, mum, etc) and discuss spacing of plant due to oncoming winter.
2. In planting poinsettias, discuss the importance of early growth for dark green thick leaves and why growth in October and November will not be as good.
3. Grow Easter liliea and discuss how plants must accumulate hours of light in order to flower - Easter determining how many days earlier to plant.
4. Grow poinsettias, mums, Kalandroe, Christmas cactus and discuss how light affects the flowers of short day plants.
5. Discuss cut flowers and how light intensity reduces the life of the flower.
6. When discussing greenhouse construction, discuss the north side of the house and why light increases 20-30% during the winter.
7. Grow plants near the window without rotating them - observe. Begin the activity on Friday and observe the plants again on Monday.
8. Observe flowering plants outdoors at morning, noon and late afternoon. Note the change of the position of the flower. Compare class results and discuss why different classes have different answers.
9. Induce plants to flower or not flower by artificial means.
   Short day plants — see information sheet on
   Long day plants — flowering
10. Plant zinnia plants in a cool shaded area and after 2-3 weeks compare disease problems. Powdery mildew should form on the low light plants - a similar demonstration can be done with begonias or turf on the north side of a home.
11. Attempt growing lettuce and cyclaneer seed exposed and not exposed to light; compare results.

IX. References and aids:

1. Lights and Plants Experiments - A series of experiments demonstrating light effects on seed germination, plant growth and plant development - Miscellaneous Publication No. 879 USDA - Agricultural Research Service

   A. Light and seed germination

      1. Effect of light on germination of seeds planted in soil . . . .
      2. How to test various kinds of seeds to determine their light requirement for germination . . . .
      3. Effect of duration of imbibition period (soaking) on effectiveness of a given light exposure in promoting germination of light-sensitive seeds . . . .
      4. How a light requirement for germination can be induced in seeds that normally do not require light for germination . . . .
      5. Photoreversible control of seed germination by red and far-red light . . . .

   B. Light and plant growth

      1. Control by light of the growth of an internode . . . .
      2. Control by light of growth and chlorophyll formation . . . .
      3. Why plants bend toward light (phototropism) . . . .
      4. Effect of red and far-red light on elongation of stems of light-grown plants. . . . .

   C. Light and plant pigments

      1. Effect of light on formation of anthocyanin in seedlings . . . .
      2. Effect of light on tomato skin and fruit color . . . .
      3. Localization of response to light by the pigment in tomato skin . . . .
      4. Effect of light on coloration of apples . . .

   D. Duration of light

      1. Photoperiodic control of flowering of short-day plants . . . .
      2. Photoperiodic control of flowering of long-day plants . . . .
      3. Photoperiodic control of growth and dormancy of woody plants . . . .

        4. Photoperiodic control of bulb formation of onions . . . .

2. Lighting for Plant Growth by Bickford, Elwood and Stuart Donn, The Kent State University Press, 1972, p. 221

3. 50 Laboratory Exercises for Vocational Ornamental Horticulture, Compiled by Paul Hemp, The Interstate Printers and Publishers, Danville, Illinois

    A. "Effects of Light and Darkness on Plants" p. 109 & 110

    B. "Effect of Different Light Colors on Phototropism" p. 113 & 114

    C. "Effects of Light on Photosynthesis" p. 115 & 116

4. Laboratory Exercises on:

    A. "Light Requirements for House Plants"

    B. "Determining Foot Candles of Light"

    C. "Effect of Light Intensity of Plant Growth"

    D. "Effect of Light Photoperiod on the Flowering of Herbaceous Plants"

5. Transparencies and Transparency Discussion Guide

6. Sample Test Questions

7. Vocational Agriculture Service Units:

    A. # 5019 "Caring of Pot Plants in the Home"

    B. # 5007 "Growing Plants Indoors"

8. Growing Plants Indoors, Taylor, J. Lee, Burgess Publishing Company, 1977, Minneapolis, Minnesota Read p. 26, 36, 40

9. Foliage House Plants, Crockett, James Underwood and Time Life Books, Time Life Book, New York, 1972, Read p. 33 to 36

LABORATORY EXERCISE

LIGHT REQUIREMENTS FOR HOUSE PLANTS

I. Objectives Given a house plant, determine the light requirements of the plant and then place the plant in the proper location in the home with consideration of available light.

II. Introduction:

Bright light or full sun. Preference for growth: 4000-8000 foot candles, for average day length. Tolerance, for maintenance: 500-2000 foot candles, based on 16 hr. illumination. Intense light is important to most blooming plants, shrubs and trees, also flowering bulbs. Many plants which require sunlight for normal growth can be kept in good condition in the home at much lower light intensity, with artificial light, when maintenance only is desired.

Filtered or diffused sunlight. Preference: 1000-3000 foot candles for average day length. Tolerance: 100-1000 foot candles, based on 16 hr. illumination. A simple indicator of diffused sunlight is to pass your hand over your plants and barely see its shadow. A place near a clear east window during summer is best, but a southern exposure must be lightly shaded from direct sun by slatted Venetian blinds, a bamboo screen, or curtain. For mere maintenance of most plants in this group in good condition in the home, light intensity may go as low as 25 foot candles, though 100 would be better.

No (direct) sun, shady, or away from sun. Preference: 50-500 foot candles for normal day length. There are very few plants which do not want some sunlight by preference; shade lovers are limited mostly to delicate plant from the forest floor, and ferns. However, a great number of subjects tolerate a minimum amount of energy-giving sunlight, and most of them are classified under the numeral 1 or starred (*). Under artificial illumination, light intensity may be as low as 10 foot candles, but the higher intensity light would be preferable to these plants provided they are shielded from the sun. High humidity is important to the well-being of plants in this group.

III. Procedure:

1) Identify a plant with a plant label. Include the common name of the plant as well as the scientific name.

2) On the plant label put one of the three letters B, F or N to identify light requirements for future reference.

IV. Observations:

LABORATORY EXERCISE

DETERMINING FOOT CANDLES OF LIGHT

I. Objective: Given a potential area for growing a plant determine the amount of light available (in foot candles)

II. Materials:

1) Camera with a light meter

III. Procedure:

1. Set the film speed dial to ASA 25
2. Set the shutter speed to 1/60
3. Place an opaque piece of white paper in the location where the plant will be placed
4. The entire field of the camera should be white when viewing the paper
5. Adjust the F-stop, lens opening, until the built-in meter indicates a correct exposure
6. Read the F stop
7. If F/2 then you have 40 Ft candles of light

F/28	75
F/4	150
F/5-6	300
F/8	600
F/11	1,200
F/16	2,400

IV. Observations:

LABORATORY EXERCISE

EFFECT OF LIGHT INTENSITY ON PLANT GROWTH

I. Objectives:

1. To develop the ability to determine the influence of light intensity on plant growth.

2. To develop an understanding, through observation, of the light requirements of various plant species.

II. Materials:

1. Five cuttings of Chrysanthemum and five small African violet plants per student. Other plants such as Philodendron may be used. The number of plants may be reduced if space is limited.

2. Shadecloth, such as cheesecloth (double layered).

3. A light meter that will measure foot candles.

4. Suitable growing area in the greenhouse.

III. Procedure:

1. Decide upon the time of the year that the demonstration is to be carried out. It should be done during a time when high light intensity periods are expected. In the Great Lakes area, during the school year, this would be during the months of September and October or from March through June. The latter dates are preferred.

2. Have each student place one of the plants of each species for which he or she is responsible in a full sunlight situation, that is with no shade restrictions, and care for them in the normal manner.

3. Place the remainder of the plants in a location in the greenhouse under shade cloth.

4. Regulate the light striking the plants by adding or taking away layers of shadecloth so that there will be two plants (one of each species) growing at each of the following light intensities: 500 foot candles, 1,000 foot candles, 2,500 foot candles, and 5,000 foot candles.

5. Care for all plants as you would under normal greenhouse procedure with regard to water, temperature, and fertilizing.

6. Observe and record the results of the differences in growth that occur in the different areas of light intensity using the following chart as a guide.

EFFECT OF LIGHT INTENSITY ON RATE OF GROWTH

	Time of			Rate		of		Growth
Size at	year	Begin.	Full	Shade & Artifical Light				end of
Plant	performed	size	sun	500FC	1000FC	2500FC	500FC	period

A separate chart for weekly observation may be used or the above chart may be adapted to this use. The size of plants may be measured in terms of height, weight, and possibly in terms of amount of foliage if the same care is given to all plants.

IV. Application:

Intensity refers to the amount of light which plants receive. Increasing light intensity on high sun-requiring plants usually results in greater photosynthesis where natural shading of leaves by other leaves occurs. Since many plants are grown in a small area, there is much natural shading that will occur and for this reason as much sunlight as possible should be admitted to permit maximum photosynthesis. Assuming that all other growth factors are equal, plants that require a high amount of sun and that are subjected to shade from gutters, eaves, adjoining buildings, and other restrictions, will not make as much growth as plants that are not shaded. The degree of light intensity required varies according to the different species of plants.

It should be noted that generally, as light intensity increases, so does temperature and this makes it necessary to water more frequently the plants growing in high light intensity.

Light intensity that is too high causes injury to the leaves of some plants. This problem can be further studied using a plant physiology text.

LABORATORY EXERCISE

EFFECT OF PHOTOPERIOD ON THE FLOWERING OF HERBACEOUS PLANTS

I. Objectives:

1. To determine the influence of day length on the flowering of herbaceous plants.
2. To develop an understanding of the effect on photoperiod on the distribution of plants throughout the world.

II. Materials:

1. Two (2) greenhouse bench areas.
2. A time clock that can be set to turn the lights on and off at desired times.
3. A light meter.
4. Electric wire.
5. Light bulb fixture, reflector, and supply of incandescent light bulbs (60 to 100 watts).
6. Short-day plants such as poinsettia, chrysanthemum, or kalanchoe, and long-day plants such as Boston yellow daily.
7. Black shade cloth. A black sateen cloth, 64 x 104 mesh or closer, will work.

III. Procedure:

1. Prepare two greenhouse benches as follows:
   a. Over one bench make a frame or wire carriage on which to hang the shadecloth. The shadecloth may be drawn back when not in use and then put over the bench from 4:00 p.m. to 8:00 a.m.
   b. The second bench wll be lighted. Place electric light bulbs over the bench at a height of four feet above the plants. The string of lights should be aligned down the center of th bench with the bulbs about four feet apart. Use the light meter to get the desired intensity for the plants being grown.

2. Wire the lights to the time clock and set the clock so that the lights will be turned on at 4:00 p.m. each day and continue to burn until midnight.

3. Place the short-day plants under long photoperiods until the beginning of the demonstration. The long-day plants will be placed under short-day conditions until the demonstration begins.

4. Divide each cultivar (group of plants under similar care) of plants in half. Place half of the plants from each group in the bench where the lights are to be used and no others in the bench that will be artificially lighted.

5. Care for the plants in each bench using normal procedures with regard to water, temperature, and nutrition.

6. Observe and make weekly records of the differences observed in the growth of the plants. Keep a record of the amount of fertilizer and the type of care given each bench so that allowances can be made for differences other than those which would be normal result of light difference. Develop a chart and compare lengths of time for flower bud formation, bud development, flowering, and flower size and quality.

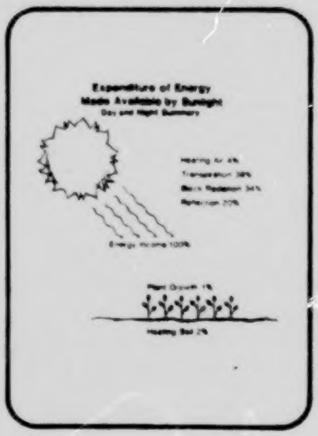
IV. Application:

Photoperiod (the length of the daylight in any 24-hour period) determines whether many plants will flower or remain in a vegetative condition. Plants are called short-day plants if they flower when exposed to relatively short daylight periods or long-day plants if they require more than a relatively long period of daylight. The light requirement varies according to the species and in many cases species of plants will be found where the photoperiod is best suited for them. There are also plants such as roses and carnations which flower under any day length regime. Such plants are called day-neutral plants. If proper temperatures are provided they will grow nearly any place in the world.

There are many practical (applied) as well as basic approaches to photoperiod that are being used today. One example of a practical approach is the greenhouse flower grower who regulates photoperiod as an aid in timing various flower crops to bloom so that they will be on the market at the right time. In basic research, much is yet to be learned about the chemical stimuli which induces flowering. Photoperiod regulation is one method used in attempting to find out more about these plant processes.

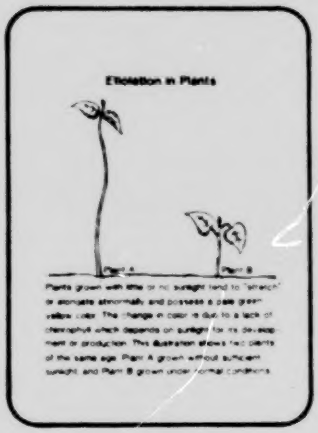
One also becomes aware of the effect of photoperiod when considering the world distribution of plants. On the equator, where there are twelve hours of light and twelve hours of darkness every day throughout the year, temperature and photoperiod permit only day-neutral and short-day plants to mature. From this example and by studying locations of optimum plant growth throughout the rest of the world, one may get a very good idea of the distribution of plants in relation to photoperiod.

ENVIRONMENTAL FACTORS


Expenditure of Energy
Made Available by Sunlight
Day and Night Summary
Heating Air 4%
Transpiration 38%
Back Radiation 34%
Reflection 20%
Energy Income 100%
Plant Growth 1%
Heating Soil 2%

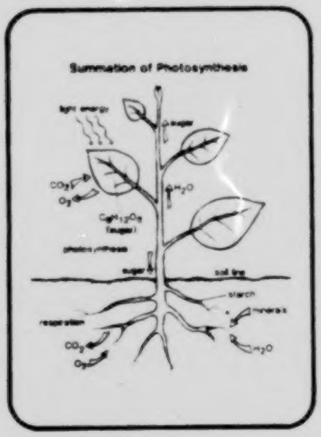
Lighting

5. The majority of greenhouse crops (flower crops) require full sunlight for maximum growth. Full sunlight in the summer months may be as high as 10,000 to 15,000 foot candles and as low as 500 to 2000 foot candles in mid-winter. Each day these foot candles begin at a low level at sunrise, peak during the midday and decrease at sunset. With this information in mind, the plant still will use about one percent of radiated sun energy for plant growth. The remainder of the sun's energy will be consumed elsewhere. Black radiation is the absorption of energy by air borne particles.


Etiolation in Plants
Plant A
Plant B

Plants grown with little or no sunlight tend to "stretch" or elongate abnormally and possess a pale green-yellow color. The change in color is due to a lack of chlorophyll which depends on sunlight for its development or production. This illustration shows two plants of the same age. Plant A grown without sufficient sunlight, and Plant B grown under normal conditions.

6. Etiolation is the term usually applied to plants growing without light. Etiolated plants usually lack chlorophyll, and show elongation of stems. This is a problem of any young seedlings that germinate and grow when light and temperature are not at the optimum for that species. Plants grown with little sunlight and excessively warm temperatures tend to "stretch" abnormally and are pale in relation to their natural color. Etiolation will occur in plants with alternate or opposite leaf arrangement, monocots or dicots.


Summation of Photosynthesis
light energy
sugar
CO2
O2
H2O
C6H12O6 (sugar)
photosynthesis
sugar
soil line
starch
minerals
respiration
CO2
O2
H2O

7. Photosynthesis is a process in which carbon dioxide and water, in the presence of light, are transformed into organic compounds. This activity includes the transformation of light energy into chemical energy. The process is initiated when light energy, affected by temperature, is trapped in the leaf and thus, splits water in the leaf into hydrogen and oxygen. In the second step, hydrogen that has been split from water combines with carbon dioxide and forms sugars. The stored sugars increase plant growth, and excesses oxygen and carbon dioxide are given off. Below ground the plant is taken up moisture, and dissolved nutrients in water.

SAMPLE TEST QUESTIONS

1. Explain how the following are affected by light?

   a. Spacing between plants

   b. Growth retardants

   c. Photosynthesis

   d. Respiration

   e. Transpiration

   f. Flower initiation

   g. Flowering date

   h. Dormancy

   i. Seed dormancy

   j. Bulb and tuber formation

   k. Internode length

   l. Branching habit

m. Leaf shape

n. Thickness of leaf

o. Post harvest life of the flower

True or False

2. T F Most angiosperms must have light for germination

T F Gymnosperms can produce their own chlorophyll

T F African violets exposed to 1200 ft candles of light will cause yellowing of the leaf

3. Describe the following terms and give examples of when enough light for subsistance is desirable: (terms to be provided by the instructor)

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

4. What effect does light have on seed germination?

5. What effect does temperature have on light?

6. Identify 5 artifical lighting sources and list the advantages and disadvantages of each.

7. Why apply "white wash" to a greenhouse in April?

8. Why do we remove shading compound on a greenhouse by September 15?

9. What is Saran Cloth?

10. Why does Saran exist in forms providing 30-90% shade?

11. Why can Alaska grow "giant cabbage" during the summer season?

12. What effect does light have on root development of cuttings?

13. How does light affect the fall color of foliage?

14. Why is it important for plants to have their proper amount of darkness?

15. What is cyclic lighting?

16. What is a long-day plant? short-day plant? day neutral plant?

17. Explain the process of black clothing a group of plants?

18. What is determinate growth?

19. What is phototropism?

20. What are the specific characterisitcs of receiving too much light?

21. What are the specific characteristics of receiving too little light?

22. Identify the results of the following light situations -

a. Transplanting petunia seedlings in early March or early July

b. Turning lights on mums in July during dark hours

c. Having a light on in the greenhouse during October with asters present

d. Having a light on in the greenhouse during October with poinsettias present

23. Identify the 3 classifications of seed germination based on light requirements.

24. At about what date do dahlias form tubers?

25. How does day length affect tuber formation?

26. How is lighting used in the nursery industry after the germination process?

UNIT G: GROWING AND MANAGING HORTICULTURAL CROPS

PROBLEM AREA: GROWING VEGETABLES

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with ninth grade or beginning students enrolled in an agricultural horticultural occupations program. The recommended time for teaching this problem area is late winter. The estimated time for teaching this problem area is 5 to 10 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Each student will have the opportunity to develop a S.O.E. program in vegetable gardening.
2. Where appropriate, school gardens or community gardens will be encouraged.
3. The Cooperative Extension Service, Park Districts, and Community College Agriculture Programs will be contacted for local gardening programs.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts these materials to his/her local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide, worksheets, information sheet and test questions were developed by Ron Biondo, Department of Vocational and Technical Education, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Horticulture

II. Problem area: Growing vegetables

III. Objectives: At the close of this problem area, students will:

1. Understand the steps in planning a vegetable garden.
2. Know how to select and prepare a garden site.
3. Be familiar with the major vegetables grown in Illinois.
4. Know the factors to consider when selecting vegetable varieties and seed.
5. Know how and when to start seeds or transplants in a garden.
6. Know how to care for a vegetable garden.

IV. Suggested interest approaches:

1. Ask the class the following lead question: Did any of you have a vegetable garden last year? What types of vegetables did you grow?
2. Ask the class to identify advantages of vegetable gardening at home.
3. Present figures to show the importance of gardening and the increased interest people have in gardening.
   (A 1980 estimate for vegetables grown in a 25′ x 30′ garden was more than $500.)
4. Ask the class to identify the best gardener they know and have them describe this person's gardening program.
5. Ask the class to respond to the following questions:
   a. How many of you would like to start a garden project?
   b. How many of you would be interested in exhibiting vegetables at a fair?
   c. How many of you would like to earn money from gardening?
6. Ask the students why tomatoes are considered fruit and why carrots, roots and celery—petioles.

V. Anticipated problems and concerns of students:

Planning the garden

1. Why is it helpful to lay the garden out on paper?
2. At what time of the year should I begin to plant my garden?
3. How can trees and shrubs near the garden affect vegetable growth?

4. Do all vegetables require full sunlight?

5. What are the major vegetables grown in Illinois?

6. What are the different plant structures that are eaten?

7. What is a variety?

8. What is meant by the term "hybrid"?

9. What does "germination rate" mean?

10. What is the meaning of disease resistance?

11. Why is spacing between the rows important?

Preparing the garden

12. What is meant when referring to "good" soil?

13. Where can one have soil tested?

14. How can soil tilth be improved?

15. How can I tell if the soil is too wet to work?

Planting the garden

16. What are the reasons for using transplants?

17. Can vegetable seed be saved and used the following year?

18. How do freeze dates relate to the planting of vegetables?

19. What benefits do transplants have over seed grown vegetables?

Caring for the garden

20. Why are chemical herbicides seldom used in vegetable gardening?

21. In what ways do weeds compete with vegetables?

22. How often does a vegetable garden need to be watered?

23. Can I use the same insecticides used on farm crops in the vegetable garden?

24. Will my vegetables be harmed if I use black walnut leaves for a mulch?

VI. Suggested learning activities and experiences:

1. Discuss the advantages of having a home vegetable garden.

2. Discuss why it helps to plan the vegetable garden in advance.

3. Introduce the students to terms commonly used when speaking about vegetable gardens. Have them complete Student Worksheet 1 on matching common terms.

4. Discuss the important factors in selecting a growing site for vegetables.

5. Give an out-of-class exercise. Have the students make a sketch of their home property, indicating the approximate locations of buildings, trees, fences, etc. Then, ask them to select two sites they feel are suitable to locate a garden.

6. Discuss the improvement of soil tilth, soil testing, fertilization, and the preparation of soil in the garden.

7. Have students collect soil in the school yard and prepare it for a soil test. Have the soil tested, then discuss any treatment that would be needed to make it suitable for a vegetable garden.

8. Identify the major vegetables grown in Illinois and discuss their edible parts.

9. Have the students complete Student Worksheet 2 on garden vegetables. Use **Vegetable Gardening for Illinois** as a reference.

10. Provide a list of major vegetables. Include figures on recommended spacing between rows and inches between plants after thinning or transplanting. Refer to Page 24 of **Vegetable Gardening for Illinois** for information.

11. Explain the selection of vegetable varieties.

12. Discuss what is important to look for when selecting seed or transplants.

13. Have the students order tomato seeds from a catalog. Plant the seed in class, and let each student take home some plants.

14. Have the students complete a worksheet on the labeling of seed packets.

15. Explain how to sow seed and transplant vegetables.

16. Discuss frost free days and freeze dates in Illinois.

17. Provide a handout on freeze dates, frost free days in Illinois, and planting dates for vegetables in Illinois gardens. Information on these topics may be found on Pages 21 and 23 in **Vegetable Gardening for Illinois.**

18. Have the students plan a home vegetable garden out of class, using the Student Worksheet 3 for sketching the vegetable garden. The assignment should include the selection of at least 12 different vegetables, spacing of the vegetables, and the planting date for each vegetable. An example garden plan may be found on Page 26 in **Vegetable Gardening for Illinois.**

19. Provide Student Worksheet 4 for planning a vegetable garden, and have the students record information on 12 different vegetables. The information needed can be found in **Vegetable Gardening for Illinois.**

20. Discuss the importance of weed control in the vegetable garden. Also, discuss the methods used to control weeds.

21. Discuss when and how to water a vegetable garden.

22. Discuss how to control disease and insect pests in a vegetable garden.

23. Discuss the types of hand and power tools used in vegetable gardens.

24. Distribute **Fruit or Vegetable Production Record Book** to students. Assign the **Problem For Use With Fruit or Vegetable Production Record Book.**

VII. Application procedures:

1. Skills learned in this problem area should be used for home gardening purposes.

2. The skills learned will be valuable for students who plan to work in garden centers.

VIII. Evaluation:

1. Collect and evaluate worksheets.

2. Evaluate students performance skill in planning and caring for a garden.

3. Administer and grade a test upon the completion of this problem area.

4. Evaluate students ability to keep and use the record book problem.

IX. References and aids:

1.	**Vegetable Gardening for Illinois**	J. S. Vandemark and J. W. Courter U. of I. Cooperative Extension Service Circular 1150
2.	**Crocketts' Victory Garden**	James Underwood Crockett, 1977 WGBH Educational Foundation, Inc. Published by Little, Brown & Co.
3.	**Fruit or Vegetable Production Record Book**	Vocational Agriculture Service 434 Mumford Hall Urbana, IL 61801
4.	**Problem for Use with Fruit or Vegetable Production Record Book**	Vocational Agriculture Service 434 Mumford Hall Urbana, IL 61801

5. Supplementary materials found in this packet:

   a. Student Worksheet on Matching Common Terms
   b. Student Worksheet on Garden Vegetables
   c. Student Worksheet for Sketching the Vegetable Garden
   d. Student Worksheet for Planning a Vegetable Garden

STUDENT WORKSHEET 1

MATCHING COMMON TERMS

______1. Viable

______2. Cool Season Vegetable

______3. Hybrid

______4. pH

______5. Rotation

______6. Organic Matter

______7. Transplanting

______8. Germination

______9. Pole-type

______10. Hardy

______11. Leaf Crop

______12. Tilth

______13. Fruit Crop

______14. Compost

______15. Seed

______16. Fertilizer

______17. Bush type

______18. Root Crop

______19. Warm Season Vegetable

______20. Tolerant

A. The moving of a plant from one location to another.

B. Vegetables grown for their edible roots.

C. Vegetable grown for their edible leaves.

D. Vegetables grown for their fruit.

E. Decomposing animal or plant matter.

F. Material used to supply one or more elements for plant growth.

G. A mixture of decayed plant material.

H. Those vegetables that perform better in cool weather.

I. Those vegetables that perform better in warm weather.

J. Self supporting plant.

K. Non-self supporting plant.

L. The practice of changing the locations of crops in the garden from year to year.

M. The sprouting of seed.

N. Plant produced from the cross between the different species.

O. Ripened ovule containing plant embryro.

P. Seed which are live and capable of germination.

Q. Vegetable tolerant to light frosts and cool weather.

R. Acidity or alkalinity of soil.

S. Ability of plants to withstand adverse conditions.

T. Ability of soil to be broken down into fine crumbs.

STUDENT WORKSHEET 2

GARDEN VEGETABLES

List 6 vegetables grown for their leaves or greens.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

List 6 types of vegetables usually transplanted to the garden.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

List 6 types of vegetables started in the garden as seed.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

List 6 vegetables grown for their fruit.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

List 6 vegetables grown for their underground structures (roots, tubers, bulbs).

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

STUDENT WORKSHEET 3

SKETCHING THE VEGETABLE GARDEN

1. Select 12 different vegetables and locate them below as you would in your garden.
2. State the planting date and spacing requirements for each vegetable.

North

30′

25′

Scale: ¼″ = 1′0″

STUDENT WORKSHEET 4

PLANNING A VEGETABLE GARDEN

I. **Introduction:**

The purpose of this exercise is to provide a means in which the student can efficiently plan a vegetable garden.

II. **Objective:**

At the conclusion of this exercise, students will have gathered and organized the vital information for planning a garden. From the plans developed, students will be able to plant a vegetable garden.

III. **Procedure:**

While referring to **Vegetable Gardening for Illinois**, record the following information for 12 vegetables: Name (including variety name), number of plants to be grown, the recommended distances between rows and plants (page 24), the length of the row, expected yields (page 3), dates of planting (page 23), type of planting (seed or transplant), and planting depth of seed (page 22).

Name ________________ Period ______

STUDENT WORKSHEET 4 – PLANNING A VEGETABLE GARDEN

Name of Vegetable	Number of Plants	Distance between: Rows	Distance between: Plants	Length of Row	Expected Yield	Date of Planting	Type of Planting Seed/Transplant	Depth of Seed
Tomato 'Early Girl'	4	3'	2'	8'	53 lbs.	May 15	Transplant	--------

TEACHER'S KEY
STUDENT WORKSHEET 1

MATCHING COMMON TERMS

P 1. Viable
H 2. Cool Season Vegetable
N 3. Hybrid
R 4. pH
L 5. Rotation
E 6. Organic Matter
A 7. Transplanting
M 8. Germination
K 9. Pole-type
Q 10. Hardy
C 11. Leaf Crop
T 12. Tilth
D 13. Fruit Crop
G 14. Compost
O 15. Seed
F 16. Fertilizer
J 17. Bush type
B 18. Root Crop
I 19. Warm Season Vegetable
S 20. Tolerant

A. The moving of a plant from one location to another.
B. Vegetables grown for their edible roots.
C. Vegetable grown for their edible leaves.
D. Vegetables grown for their fruit.
E. Decomposing animal or plant matter.
F. Material used to supply one or more elements for plant growth.
G. A mixture of decayed plant material.
H. Those vegetables that perform better in cool weather.
I. Those vegetables that perform better in warm weather.
J. Self supporting plant.
K. Non-self supporting plant.
L. The practice of changing the locations of crops in the garden from year to year.
M. The sprouting of seed.
N. Plant produced from the cross between the different species.
O. Ripened ovule containing plant embryro.
P. Seed which are live and capable of germination.
Q. Vegetable tolerant to light frosts and cool weather.
R. Acidity or alkalinity of soil.
S. Ability of plants to withstand adverse conditions.
T. Ability of soil to be broken down into fine crumbs.

TEACHER'S KEY
STUDENT WORKSHEET 2

GARDEN VEGETABLES

List 6 vegetables grown for their leaves or greens.

1. Broccoli
2. Cabbage
3. Lettuce
4. Spinach
5. Parsley
6. Rhubarb

List 6 types of vegetables usually transplanted to the garden.

1. Broccoli
2. Brussel Sprouts
3. Cauliflower
4. Tomato
5. Pepper
6. Rhubarb

List 6 types of vegetables started in the garden as seed.

1. Beans
2. Carrots
3. Sweet Corn
4. Cucumber
5. Lettuce
6. Radish

List 6 vegetables grown for their fruit.

1. Beans
2. Pepper
3. Sweet Corn
4. Cucumber
5. Tomato
6. Pumpkin

List 6 vegetables grown for their underground structures (roots, tubers, bulbs).

1. Beet
2. Carrot
3. Onion
4. Potato
5. Turnip
6. Parsnip

TEACHER'S KEY

SAMPLE TEST QUESTIONS ON VEGETABLE GARDENING

Completion Section

1. A plant that can withstand light frosts and cool temperatures is considered hardy.
2. Young plants which are crowded should be thinned to allow plenty of room for growth.
3. Moving a plant from one location to another is called transplanting.
4. Organic matter may be added to soil to improve tilth.
5. Dead leaves, food scraps and grass clippings can be placed on a compost pile to decay.
6. Soil tests tell you the pH of the soil and content of nitrogen, % organic matter, phosphorus and potassium.
7. When watering the vegetable garden it is a good practice to soak the soil to the depth of 6 - 8 inches.
8. Leaves that remain wet for extended periods of time may be susceptible to disease.
9. During the drought periods watering may be necessary every 7 - 10 days.
10. Morning is the best time of the day to water a garden.

Listing Section

1. List 4 factors to consider when selecting a vegetable garden site.
    1. Soil
    2. Sunlight
    3. Away from obstructions
    4. Close to home
2. List 3 types of mulches
    1. Wood chips
    2. Grass clippings
    3. Straw
    4. Peat moss
    5. Black plastic

3. List 3 types of vegetables usually transplanted to the garden.

   1. Broccoli
   2. Brussel Sprouts
   3. Cauliflower
   4. Tomato
   5. Pepper
   6. Rhubarb

4. List 3 types of vegetables started in the garden as seed.

   1. Beans
   2. Carrots
   3. Sweet Corn
   4. Cucumber
   5. Lettuce
   6. Radish

5. List 3 vegetables grown for their fruit

   1. Beans
   2. Pepper
   3. Sweet Corn
   4. Cucumber
   5. Tomato
   6. Pumpkin

6. List 3 vegetables grown for their underground structures (roots, tubers, bulbs)

   1. Beet
   2. Carrot
   3. Onion
   4. Potato
   5. Turnip
   6. Parsnip

TRUE–FALSE SECTION

F 1. Use of herbicides is the most common method of weed control in the vegetable garden.

F 2. All vegetables must be planted after the average frost free date in your area.

T 3. Transplants will recover from transplant shock more quickly if planted on a cloudy day or in the evening.

T 4. The quality of the soil will affect the quality of your vegetables.

F 5. All vegetables do equally well in full sun or deep shade.

T 6. Vegetable gardening is rising in popularity partly because of high food costs.

T 7. Proper spacing of vegetables reduces competition for light, water and nutrients.

T 8. Planning a garden on paper helps eliminate the chance of underplanting or overplanting.

T 9. Different vegetable seeds have different germination requirements.

F 10. Soil tilth can only be improved by roto-tilling.

T 11. The three major nutrients used by plants are nitrogen, phosphorus, and potassium.

F 12. It is a good practice to water your garden for about five minutes every day.

T 13. Some vegetable varieties are more desirable than others.

T 14. Soil tests and the gardener in determining how much, if any, fertilizer, organic matter, lime or acidifying material should be added.

F 15. It is best to work soil after a heavy rain.

UNIT H: Identifying and Controlling Pests of Horticultural Plants

PROBLEM AREA:

1. Pest identification and safe use of pesticides

UNIT H: IDENTIFYING AND CONTROLLING PESTS OF HORTICULTURAL PLANTS

PROBLEM AREA: PEST IDENTIFICATION AND SAFE USE OF PESTICIDES

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshmen or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the spring semester as pests become a problem outdoors.

The estimated instructional time for this problem area is 15 to 20 days depending on how far the teacher wishes to go in developing insect, disease, pollution, identification, and safe use of pesticides skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instruction can be 10 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this packet are for reference or modification as instructors adapt this problem area to their local situation.

CREDIT SOURCES:

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The teacher's guide, and student worksheets, were developed by Jim Ethridge. Transparency masters, the transparency discussion guide, and test question were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Identifying and Controlling Pests of Horticultural Crops

II. Problem area: Pest identification and safe use of pesticides

III. Objectives: At the close of this problem area each student will--

1. Develop an understanding of the importance of prompt identification of pests.
2. Develop competencies needed to identify pest problems.
3. Develop competencies needed to apply the proper control technique safety.
4. Understand the problems in growing ornamental plants and to plan preventatives and controls in solving those problems.
5. Develop the ability to diagnose plant pests.
6. Differentiate between harmful and beneficial insects.
7. Explain the life cycle of pests and how they are used in controls.
8. Diagnose plant pest problems by identifying the symptoms.
9. Classify pesticides according to biological and chemical methods.
10. List the major contributors in agriculture to the pollution problem.
11. Determine proper preventative control measures.
12. Recognize danger of improper use of pest control.
13. List the major air pollutants and their effect on plants.

IV. Suggested interest approaches:

1. Bring in samples of bread mold, citrus green mold, molding lettuce, cut flowers molding in the cooler, mildew on turf from the north side of the house. Discuss these pests in class.
2. Collect pictures of plants which have been damaged by mice, moles, rabbits, deer or other animals.
3. Conduct a class contest on identification of pests and evidence of their damage.

4. Have the students diagnose several problems and prescribe a suggested control procedure.
5. Have the students apply the proper control.
6. Have students complete a plant diagnosis check sheet.
7. We have lost a lot of seedling plants in the garden. They appear O.K. one day, and the next morning we find them cut off at the surface of the ground. What causes this? How can we avoid the loss?
8. We have some plants that break over each summer. When we examine the stem, we find a borer in the stem. How can we prevent these borers? There does not seem to be any way to get sprays into the stems to kill the borer after it gets into the stem.
9. The fruit growers in our area rent bees to put in their orchards. What is the importance of bees in this situation? How can bees become pest problems?

V. Anticipated problems and concerns of students:

1. What are the common greenhouse pests?
2. Are there air pollution problems anywhere in Illinois?
3. What are the common woody pests?
4. What are the common herbaceous pests?
5. What are the leading pollution problems in agriculture?
6. What are the common lawn pests?
7. Is odor considered an air pollutant?
8. How can we identify the pest damage to floral crops?
9. How can we identify the pest damage to lawns?
10. Is carbon dioxide an air pollutant?
11. What are the identifying characteristics of common pests?
12. What is it important to be able to identify the more common pests?
13. Why control the pest?
14. What materials are needed for effective pest control?

15. Does Illinois have air pollution control rules?

16. What procedures should be followed in using chemical materials safely?

17. What safety precautions must be observed?

18. What is a physiological disease?

19. What is a nutritional disease?

20. What management practices may be used to prevent pests and control diseases?

21. How does temperature affect pests?

22. How are diseases disseminated?

23. What life cycles exists for insects?

24. What types of insects should we be concerned about?

25. How does one control chewing insect, sucking insect, and soil insects differently?

26. How does air pollution affect plants?

27. How do plant pests affect plants?

28. How does one recognize a plant pest?

29. What other types of pests exist?

VI. Suggested learning activities and experiences:

1. Ask the class for information on any horticulture problems that they may have seen or heard of in the community and make a list. Discuss. Handle insect, weeds, diseases, and physiological problems separately.

2. Discuss the problems and bring in information relating to them.

3. Arrive at a solution or condition which will cure the problems.

4. Study the different types of insecticides, pesticides, and fungicides as to their uses, advantages, and disadvantages.

5. Head a class discussion with the following problem: The leaves on our roses and on the apple trees have a great many black or brownish spots on them. What is the probable cause? Is there any control for these problems?

6. Head a class discussion with the following problem: The retail seed store says the crop seeds are all treated for diseases carried on the seed. What kind of diseases are these? Is it best to buy this treated so these diseases can be avoided?

7. We read about plants that are resistant to pests. What resistant varieties are suitable for your area? Demonstrate resistant varieties.

8. Prepare an exhibit showing life cycle of pests (insects, diseases, weeds). It should show the point(s) in the life cycle where the pest may be controlled.

9. Observe the pest - mechanical injury.
   a. Lawn mower running into trees.
   b. Lawn mower improperly sharpened.
   c. Lawn mower leaking oil.
   d. Lawn mower mowing too close.
   e. Spraying - overdose and burn.
   f. Poor pruning wounds.

10. Have students prepare mounted specimens of plant pests (insects or diseases).

11. Have the students prepare a collection of common pests and evidence of damage.

12. Have students practice selecting and applying the proper control technique.

13. Have students collect the following pests from the following areas:
    a. Insects
    b. Diseases
    c. Pollution
    d. Physiological problems

    AA Indoor flowers and foliage plants
    BB Outdoor flowers and foliage plants
    CC Shrubs ornamental
    DD Trees fruit
    EE Shade trees
    FF Fruit shrubs
    GG Lawn or turf area

14. Students construct protective devices (example: wire mesh barriers around apple trees to discourage rabbits) as a community service.

15. Conduct a community safety program on the proper use of pest controls.

16. Perform Dutch Elm disease test on branches brought in by students from their home.

17. Make a field trip to identify local weeds and have students obtain specimens for use in classroom collection.

18. Develop a spray schedule for plants found in the students' home area.

19. Have each student collect five plant problem questions from people in the community and do research to answer these questions.

20. Special projects, research. Example: Survey community to find out what pests are most common.

21. Write articles on methods of pest control and have published in the local newspaper.

22. Students may collect specimens showing damage done by various kinds of chewing insects. These may be mounted to form a display, and each specimen may be labeled with the name of the insect causing the damage.

23. Students may collect and mount pictures of each common kind of chewing insect. Each picture may be labeled with the name of the insect and the method of control which is recommended.

24. Students may make collections of insects and label each with a name, type of insect (i.e. chewing or sucking), method of control.

25. Each student (or committee of students) may be assigned to prepare a display showing the life cycle of a specific insect and to indicate the points at which it may be controlled.

26. Students may be assigned to study literature which is available and to prepare a report on a specific topic related to the control of insects. Such topics as the following are suggested:
    - Systematic Poisons for Control of Insects
    - Biological Controls for Insect Pests

VII. Application procedures:

1. The main purpose of this problem area is to teach information and develop ability of the student to recognize pest-related physiological activities.

2. The application phase should be emphasized every time a field trip is taken, when the student works in his home environment and when visiting horticultural businesses. Samples of pest problems should be brought to class for identification and to discuss control measures.

VIII. Evaluation:

1. Prepare and administer a pencil paper test using sample test questions.

2. Collect and grade worksheets and lab experiments.

3. Observe performance in working with pesticides.

IX. References and aids:

1. Information Sheet on:
    - a) "Insects: Subject Matter Outline"
    - b) "Diagnosing Greenhouse Crop Problems"
    - c) "Seeding Problems and Treatments"
    - d) "After Transplanting Problems and Treatment"
    - e) "Diagnosing Check List and Plant History"
2. Student Worksheets on:
    - a) "Being a Plant Detective"
    - b) "Insect Report Outline"
3. Sample Test Questions
4. Vocational Agriculture Service, Subject Matter Units:
    - a) # 5021 "Identifying Tree and Shrub Insects"
    - b) # 4045A "Handling and Using Pesticides Safely"
5. Vocational Agriculture Service, Subject Matter Test Question and Key

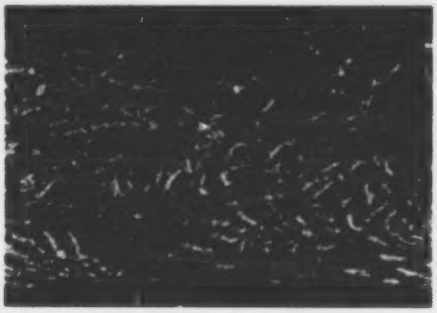
    a) # 5021 "Test Questions" and "Key to Test Questions"

6. Vocational Agriculture Service, Slide Sets:
    a) # 1108-2.2 "Identifying Common Insect Pests"
    b) # 604 "Diseases of Garden Flowers"
    c) # 1108-2.3 "Diseases of the Vegetable Garden"
    d) # 1107 "Air Pollution Damage to Vegetation"
7. Transparency Discussion Guide "Safe Use of Pesticides"
8. University of Illinois, Illinois Natural History Survey
    a) Circular # 39 "How to Collect Insects"
    b) Circular # 47 "Tree and Shrub Insect Enemies"
9. University of Illinois, Cooperative Extension Service, College of Agriculture
    a) Circular # 900 "Insect Pest Management"

Picture Sheet No. 3

COMMON TREE AND SHRUB PESTS

For safe and effective use of insecticides, always identify the problem correctly.

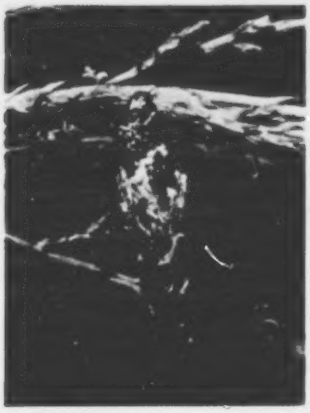

1. Oystershell scale

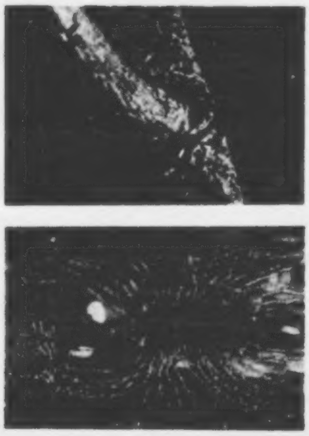
2. Maple bladder gall

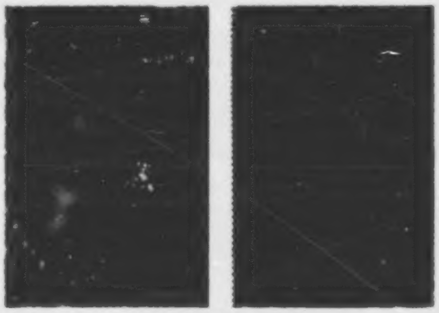
3. Flatheaded borer

4. Aphid

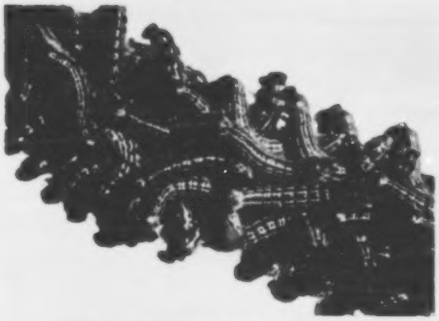
5. Pine needle scale


6. Bagworm


7. Smaller European elm bark beetle and galleries


8. Elm leaf beetle and larvae

9. Eastern tent caterpillar


10. Yellow-necked caterpillar

11. Spruce mite injury

Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U.S. Department of Agriculture

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
COLLEGE OF AGRICULTURE/COOPERATIVE EXTENSION SERVICE
and ILLINOIS NATURAL HISTORY SURVEY

NHE-119
DECEMBER, 1967
URBANA, ILLINOIS

COMMON TREE AND SHRUB PESTS

1. **Oystershell scale** (**brown race**) attacks hybrid lilac, poplar, redbud, dogwood, ash, and fruit trees. The **gray race** type usually attacks common lilac. Mature scales are found firmly attached to the branches (pictured). Here they feed by sucking sap and may eventually kill their host. Young scales or "crawlers" wander over the plant before attaching themselves to the branches. The two-generation brown race crawlers are active in early June and late July. The gray race crawlers are present in early June only. For more information see NHE-114.

2. **Maple bladder galls** appear as small, wartlike growths on the upper surface of the leaves of young silver or soft maple (pictured). They are caused by mites that overwinter in the buds and attack the leaves as soon as these buds break in spring. Although affected leaves may be distorted, the galls seldom hinder tree health and vigor. For more information see NHE-81.

3. **Flatheaded borers** attack many fruit and shade trees, but usually only those in a weakened, injured, or sunscalded condition. Silver maple is especially susceptible. The borers burrow beneath the bark into the cambium and sapwood (pictured). If left unchecked, they may eventually girdle and kill the host. Damaged areas in the trunk may be discolored and slightly sunken. For more information see NHE-8.

4. **Aphids** attack fruit trees, shade trees, ornamental evergreens, deciduous ornamentals, and many types of shrubs. They weaken their host by sucking plant sap, causing curled or twisted leaves and twigs and malformed flowers. Some species carry virus diseases from infected to healthy plants. All types secrete "honeydew," which attracts flies and ants, stains objects, and encourages growth of an unsightly sooty mold. Aphids are small, soft-bodied, and either winged or wingless, and vary in color from green to shades of red, black, and brown (pictured). They cluster on new growth or the underside of leaves but some species work underground. For more information see NHE-7.

5. **Pine needle scale,** a small, elongated, white scale, attacks most types of needled evergreens but is especially common on mugho pine. Like the oystershell scale, the pine needle scale sucks sap. Heavy populations weaken the host and may kill it. This scale has two generations a year, with the young scales or "crawlers" present in late May and again in late July. For more information see NHE-114.

6. **Bagworm caterpillars** attack both evergreen and deciduous plants, particularly firs, junipers, pines, spruces, black locust, maples, sweet gum, and sycamore. Starting in early June, bagworms begin feeding on the foliage, spinning a bag of thread and leaf bits as they feed and grow. Defoliation is apparent by July and August and is often fatal to evergreens. The caterpillar crawls part way out of the bag to feed (pictured), but retreats inside if disturbed. In late August or September, the mature worm attaches the bag to a branch or other object and changes into the adult stage. Eggs are contained in the overwintering bags. For more information see NHE-6.

7. **Smaller European elm bark beetles** are the principal carrier of Dutch elm disease. The larvae feed beneath the bark of dead or dying elms, creating galleries in which they overwinter (pictured). In spring, about the time lilacs are in bloom, small dark-brown adult beetles emerge, covered with spores of the Dutch elm disease fungus. They immediately migrate to healthy trees and feed at the twig crotches (pictured), and thus may deposit the disease spores.

8. **Elm leaf beetles** attack all elm species but prefer Chinese elm. Both larvae and adults feed on the underside of the leaves, giving them a "skeletonized" appearance (pictured). Heavily infested leaves turn brown as if scorched by fire. Adult beetles overwinter in protected sites and can be a household pest in fall and spring. Starting about mid-May, the beetles deposit their yellow eggs on the underside of elm leaves. In a week the eggs hatch and the new larvae feed until early July. Then they crawl or drop to the base of the tree to pupate. Adults emerge in about 10 days, feed on the leaves, and lay eggs for a second generation. For more information see NHE-82.

9. **Eastern tent caterpillars** feed on the leaves of numerous fruit trees and deciduous ornamentals. They are common on apple, wild cherry, and witch hazel. They overwinter in the egg stage. These eggs are deposited in bands around the twigs. As leaves emerge in spring, the eggs hatch and larvae feed on the leaves. At night and during the bad weather they cluster on their silken tent (pictured). When the host plant is defoliated, the caterpillars wander about and may invade homes.

10. **Yellow-necked caterpillars** are found on many fruit trees and ornamentals, especially pin oak. They feed in large colonies (pictured) on the leaves, causing greatest damage in July and August. Young caterpillars skeletonize the foliage, leaving only the veins and upper surface. The older ones eat all of the leaf but the mid-rib.

11. **Spruce mites,** tiny and spiderlike, are common on needled evergreens, including spruce, arbor vitae, hemlock, juniper, and some pines. They damage the needles, causing the plant to turn white, yellow, or brown. Damage occurs in early spring and usually starts at the bottom of the plant, progressing upward and outward. Close examination will reveal round, brownish eggs and almost invisible webbing over the leaves and branches (pictured). Other species of mites attack deciduous plants. For more information see NHE-58.

CONTROL RECOMMENDATIONS. This information and the colored illustrations are to help you identify common tree and shrub pests. Additional information about the specific insects can be found in the NHE leaflets listed or in Illinois Natural History Survey Circular 47, *Illinois Trees and Shrubs: Their Insect Enemies.* Current recommendations for control are given in Circular 900 of the University of Illinois Cooperative Extension Service, which is revised annually. You may obtain single copies of any of these publications from your county extension adviser or from the Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801.

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

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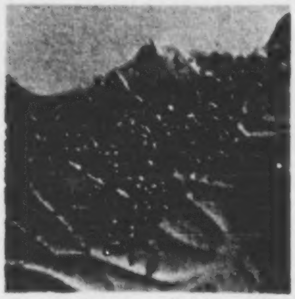
10M—12-67—9559[illegible]
4M—1-73—23708
8M—9-77—38718

COMMON VEGETABLE INSECTS

For safe and effective use of insecticides, always identify the problem correctly.

1. Cabbage looper (light green) and imported cabbageworm (dark green)



2. Cabbage aphid. Other species damage many crops.

3. Hornworm showing cocoons of parasite on back

4. Two-spotted spider mite (enlarged). Not an insect.

5. Bean leaf beetle

6. Mexican bean beetle adult, pupa, larvae, eggs, and damage

7. Thrips (enlarged)

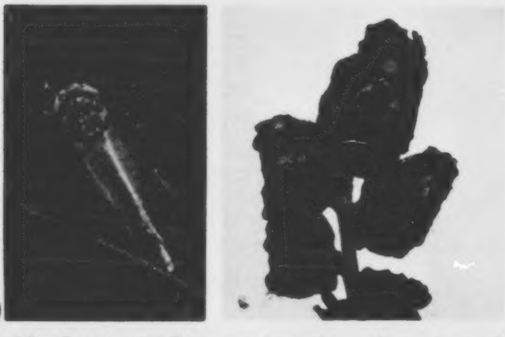
8. Root maggot and damage

9. Striped cucumber beetle

10. Spotted cucumber beetle

11. Colorado potato beetle larvae and adults

12. Potato flea beetle and damage



13. Potato leafhopper (greatly enlarged) and leafhopper damage

14. Squash vine borer and damage

15. Squash bug nymphs and adult

Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U.S. Department of Agriculture

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
COLLEGE OF AGRICULTURE/COOPERATIVE EXTENSION SERVICE
and ILLINOIS NATURAL HISTORY SURVEY

NHE-125
JULY, 1968
URBANA, ILLINOIS

COMMON VEGETABLE INSECTS

1. **Cabbage looper and imported cabbage worm** larvae are serious pests of cabbage. They overwinter as a pupa attached to old cabbage stalks. In the spring, moths lay white to yellow eggs on the underside of foliage. Newly hatched larvae eat into cabbage heads near the base of the plant and without control can cause decay of the heads.

2. **Cabbage aphids** attack many of the cole crops sucking plant juices from leaves, stems, pods, and blossoms, and causing plants to be dwarfed. Aphids usually overwinter as an egg. Nymphs hatch out in spring, feed on the plants, mature, and give birth to young. There are many generations and great numbers can develop in a short time.

3. **Hornworms** primarily attack tomato plants in Illinois, but also can be found on eggplant, pepper, and potatoes. This insect overwinters as a dark-brown pupa in the soil. The adult, a hawk or sphinx moth, emerges in late spring. It lays greenish-yellow eggs, singly on the underside of host plants. The larvae which hatch from these eggs are bright green with diagonal white stripes on the side and also with a slender horn at the rear end of the worm. These worms feed heavily for 3 to 4 weeks, destroying much of the plant foliage.

White parasite cocoons are commonly found in numbers clustered on older worms. They are the pupal stage of a wasp parasite. The parasitic wasps thrust their eggs into larvae. Eggs hatch and wasp larvae feed inside the hornworm and when fully grown emerge to spin these cocoons on the older worms.

4. **Two-spotted mites** are not true insects, but are minute eight-legged animals with many generations during the growing season. They appear as tiny specks, usually under a fine webbing. They are injurious to many vegetable crops as well as fruit and field crops. They suck the juices from the undersides of leaves, causing them to drop off after turning yellow, then brown. Mite buildup is enhanced by dry conditions.

5. **Bean leaf beetle** adults winter in soil debris near bean fields of the preceding year. In spring, these adults feed on seedlings before laying eggs at the base of bean plants. The slender, white larvae feed on roots, nodules, and stems just below ground. More adults emerge in July and August, eat irregular holes in leaves, and also feed on blossoms and pods.

6. **Mexican bean beetle** adults winter in debris on the ground, in fencerows, roadsides, and wooded areas. They move to snap and lima beans in May and June. Eggs are laid on the underside of leaves. Both larvae and adults damage bean plants by feeding on the underside and giving plant leaves a characteristic lace-like appearance. The larvae may also attack blossoms and pods.

7. **Thrips** rasp the leaf tissue of certain vegetable crops, causing white streaks to appear on leaves. Thrips of beans, onions, and vine crops may cause leaves to wither, turn brown, and fall to the ground. Drought conditions enhance thrip injury.

8. **Root maggots** of several species commonly attack vegetables. One species attacks onions; another infests cabbage, radishes, turnips, and related crops; another attacks carrots; another attacks bean and corn seeds. They overwinter as a pupa in soil where vegetables were grown. Adult flies emerge in spring and lay eggs near stems of new plants. Eggs hatch into small maggots which seek out plant roots and feed on them. Root maggots feed on fine roots and also tunnel into main roots.

9. **Striped cucumber beetle** adults winter in sheltered areas, move into newly planted fields of vine crops, and feed on young plants as they emerge. Eggs are laid near the plants. The larvae which hatch feed on plant roots. There are several generations each year.

10. **The spotted cucumber beetle** is also the adult of the southern corn rootworm. It is very similar in life cycle and damage to the striped cucumber beetle. Both species spread bacterial wilt and mosaic, two serious diseases of vine crops.

11. **Colorado potato beetles** overwinter as striped adults in soil and emerge in spring to feed on new potato seedlings. Orange-yellow eggs are laid in groups on the underside of leaves. Larvae, as well as adults, feed on potato foliage and can remove enough leaves to retard tuber growth.

12. **The potato flea beetle** is one of a group of small beetles with enlarged hind legs. It can jump when disturbed. Flea beetles usually winter as adults and appear on leaves of new potato plants in late spring. The beetles feed on the leaf surface. Moderate damage will stunt top growth and retard tuber development.

13. **Potato leafhoppers** migrate into Illinois from the Gulf states during late spring and feed on various plants by sucking plant juices. They may suddenly appear in great numbers in certain areas. On potatoes this insect feeds on the underside of leaves and secretes a toxin which causes browning of the leaf tips and edges. Leafhopper feeding can result in burning of the leaves (called 'hopperburn) which can cause complete destruction of potato vines.

14. **Squash vine borers** overwinter as pupae in cocoons in the soil. In late spring moths emerge and lay brownish, flattened eggs singly on stems of squash and other vine crops. The hatching larvae or borers feed on the plant and then after a week they tunnel into stems and feed on the inside of the vines. As with most borers, control has to be obtained while small larvae are on the outside of the stem.

15. **Squash bugs** winter as brownish-black, flat adults under old vines. They migrate in late spring to new plantings of vine crops. Brownish-bronze eggs are laid in the angles of veins on the underside of the leaves. Small nymphs which hatch feed on leaves just as do the adults by sucking out plant juices, causing leaves to dry up. Entire plants are often destroyed by squash bugs.

CONTROL RECOMMENDATIONS. These illustrations will help you identify some common vegetable insects. The appearance, damage, and habits of insects do not change, but controls do. Illinois extension Circulars 897 and 900 give suggestions on insecticide use and are revised annually. These fact sheets give more detailed life history and controls for these insects:

NHE-47	Aphids on Vegetable Crops
NHE-49	Asparagus Beetle
NHE-44	Cabbage Maggot on Cabbage and Related Crops
NHE-45	Cabbage Worm
NHE-33	Corn Earworm
NHE-40	Corn Sap Beetle
NHE-32	Japanese Beetle
NHE-50	Onion Maggot
NHE-48	Onion Thrips
NHE-51	Squash Bugs on Melon and Vine Crops
NHE-46	Striped and Spotted Cucumber Beetles
NHE-84	Slugs

You may obtain single copies of these publications from your county extension adviser or from the Agricultural Publications Office, University of Illinois, Urbana, Illinois 61801.

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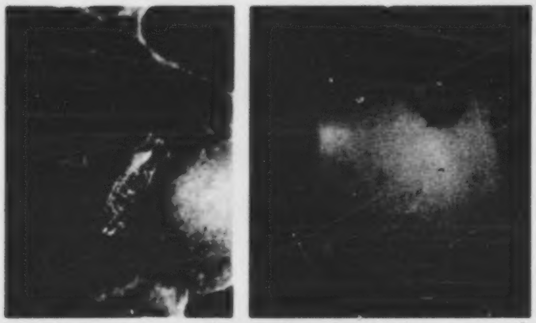
10M—7-68—97590
8M—9-77—38720

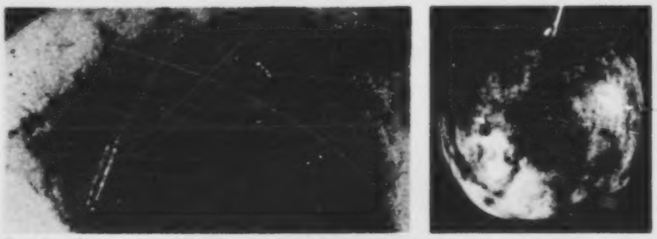
Picture Sheet No. 10

COMMON FRUIT INSECTS

For safe and effective use of insecticides, always identify the problem correctly.



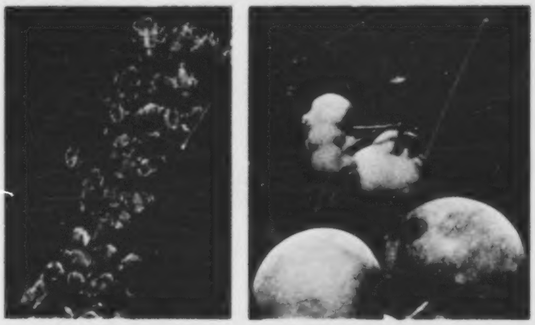
1. Codling moth adult and new larval entry, and damaged or "wormy" apple



2. Apple maggot in apple, and blotching and streaking of maggot-infested fruit

3. Red-banded leaf roller and damage

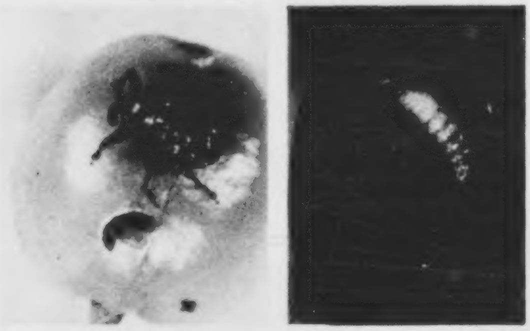
4. Green fruitworm



5. Rosy apple aphid, and deformed fruit shown with normal apples for comparison

6. San Jose scale on apple

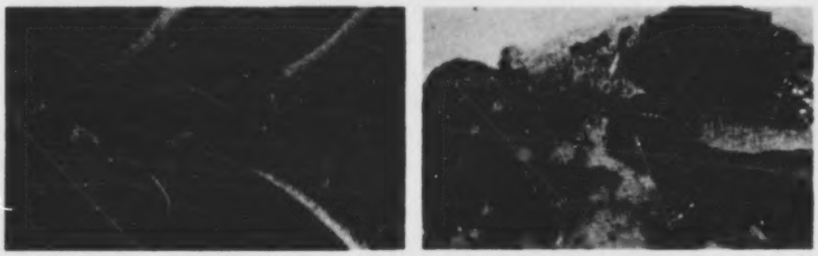
7. Cherry fruit fly maggot



8. Plum curculio adult and egg-laying slit on cherry, and curculio larva in plum

9. Two-spotted spider mite and eggs (enlarged). Not an insect.

10. Grape berry moth larva and damage



11. Oriental fruit moth. Twig damage and larva in peach.

12. Peach tree borer and pupa

Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U.S. Department of Agriculture

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
COLLEGE OF AGRICULTURE/COOPERATIVE EXTENSION SERVICE
and ILLINOIS NATURAL HISTORY SURVEY

NHE-126
SEPTEMBER, 1968
URBANA, ILLINOIS

COMMON FRUIT INSECTS

1. **Codling moth** is a serious pest of apples. It overwinters as a larva behind loose bark on the trunk of an apple tree. Moths emerge in late spring and lay eggs on leaves and fruit soon after petal fall. There are two and sometimes a partial third generation in Illinois. Larvae damage apples by chewing their way into the center of apples. "Frass" or fecal material is pushed out through the opening in the apple skin. The tunnel through the apple is an avenue for disease to attack fruit, causing it to drop.

2. **Apple maggot** mainly infests apples but may also attack plums, blueberries, and crabapples. It passes winter as a pupa and adults emerge from June to September, with most of them emerging in June. Adult flies that have dark bands on their wings and white bands around the abdomen puncture the skin of an apple and insert an egg into it. The legless maggots that hatch feed by tunneling throughout the apple flesh, leaving tiny brown trails. Egg punctures and larval feeding cause fruit to be dimpled and if it is soft it will soon rot. Apple maggots are common in northern Illinois and absent in the southern part of the state.

3. **Red-banded leaf roller** larvae feed on apple foliage and often feed on fruit. The larva overwinters as a pupa in debris on the ground. Adults emerge in early spring and lay eggs in masses on undersides of larger limbs. Egg hatch occurs at about bloom. Newly hatched larvae fold or roll leaves together with webbing and feed on foliage. There are second, third, and fourth generations in southern Illinois with the last doing damage to the surface of ripening fruit by attaching a leaf to the fruit surface and feeding on skin and flesh.

4. **Green fruitworms** are larvae of several species of moths that infest apple trees. These worms feed on foliage and also feed on and hollow out small apples. They are seldom a pest in commercial orchards with regular spray programs.

5. **Rosy apple aphid** is one of three species of aphids attacking apples, the other two being the apple aphid and apple grain aphid. Aphids on apples pass the winter as an egg laid on twigs and spurs, usually on bud scales. Egg hatch and bud opening usually occur together and the newly hatched aphids suck plant juices of newly formed leaves. Aphids cause apple leaves to curl and cause fruit clusters to be deformed. During summer rosy apple aphids migrate to plantain, an alternate host, and return in fall to lay eggs on apple trees.

6. **San Jose scales** overwinter as nymphs and begin feeding again when sap begins to flow in the tree. Female scales continue to grow and give birth to young crawlers about three weeks after petal fall. There are two to three generations in northern Illinois and four to five in the southern section. The young crawlers feed on limbs, leaves, and fruit, causing red, spotted areas. Infested leaves usually drop and limbs lose vigor and die. Fruit will have an undesirable finish because of the red, spotted appearance caused by scale feeding and the presence of the scale.

7. **Cherry fruit fly maggots** infest cherry fruit causing ripening fruit to color prematurely and to shrink and decay. It overwinters as a pupa in soil, emerging as an adult in May to lay eggs by puncturing the fruit skin. Embedded eggs hatch into yellowish, legless maggots that feed on cherry fruit flesh.

8. **Plum curculio** attack a number of fruit species, including apple, peach, plum, cherry, pear, apricot, and others. It winters as a dark-brown snout beetle in wooded areas near orchards. It becomes active at blossom time, feeding on newly forming fruit. Eggs are laid on crescent-shaped flaps cut in skin of young fruit. Hatching larvae will tunnel through fruit of peaches or plums, causing fruit to drop or rot. Egg-laying cuts made by adults give an undesirable finish to mature fruit.

9. **Two-spotted spider mites,** as well as European red mites and four-spotted spider mites, are severe pests in orchards, especially on apples. They suck juices from leaves, causing yellowing and finally bronzing of foliage. Hot, dry weather favors their development. Special miticide chemicals are usually necessary for mite control.

10. **Grape berry moth** larvae attack ripening grapes on most unsprayed grape vines in the state. Larvae spin webbing around young bunches of grapes and leaves. They feed on young grape berries. The second generation feeds inside the ripening berries.

11. **Oriental fruit moth** larvae are the most important insects of peaches and nectarines. First-generation larvae tunnel into new terminal growth, causing dieback or flagging on these twigs. If fruit is available succeeding generations enter and feed in it. Larvae feeding in fruits cause them to drop, or the wounds serve as avenues for rots. There are four generations in the central part of the state with a partial fifth in the southern part.

12. **Peach tree borers** and lesser peach tree borers attack the trunk and limbs of trees of stone fruits, especially peach trees. Peach tree borer injury occurs a few inches above or below ground and lesser peach tree borer injury may occur anywhere on the trunk or limbs where larvae can get under dead bark. Both species winter as larvae under damaged bark. Adults emerge from these wounds after mid-May and continue into September. These moths lay eggs on rough areas of bark. Young, hatching larvae must be able to get under loose bark for protection. There is usually one generation a year in Illinois for the peach tree borer and about one and a half for the lesser peach tree borer.

CONTROL RECOMMENDATIONS. These illustrations will help you identify some common fruit insects. The appearance, damage, and habits of insects do not change, but controls do. Illinois Extension Circulars 900 or 936 give suggestions on insecticide use and are revised annually. These fact sheets give more detailed life history and controls for these insects.

NHE-98	Codling Moth	NHE-101	Plum Curculio
NHE-108	Apple Maggot	NHE-99	Oriental Fruit Moth
NHE-100	Scale Insects	NHE-112	Peach Tree Borer

You may obtain single copies of these publications from your county extension adviser or from the Agricultural Publications Office, University of Illinois, Urbana, Illinois 61801.

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10M—9-68—98189
8M—2-78—40449

INFORMATION SHEET

DIAGNOSING GREENHOUSE CROP PROBLEMS

Provided by Vaughn Jacklin Corporation

In the eyes of your customers you are a specialist. If your customers are having problems they will almost always ask you for answers -- and many times you are not going to be able to answer.

By using the following check list you may be able to "smoke out" the problem when you use the check list in combination with the "Problems and Treatment."

Keep in mind that your customers live on top of their production and may be overlooking a very obvious cause to their problem -- but also remember that they probably know a lot more about their own crop than you may think they know.

It sometimes pays handsomely to go over this list with your customers. They have probably gone over some of the questions in their own mind but there may be one or more of the questions they hasn't considered.

I. Look for a pattern in symptom development.

   A. Location: portion of bench, house or range; proximity to gutters, shade cloth, CO_2 burners, heaters, etc.

   B. Greenhouse Operations: time of planting, water and fertilizer regimes, pinching, disbudding, transplanting, etc.

   C. Weather: extreme fluctuation in temperature, light, prolonged periods of unusual conditions such as dark weather.

II. Obtain history of the problem.

   A. Date symptoms first noted.

   B. Rate of development and spread or abatement.

   C. Control measures used and effectiveness - any chemical treatment?

   D. Crop rotation in area.

   E. Any problems with previous crops.

   F. Soil source, treatment.

G. Plant source and original condition (clean starting stock).

H. Uniformity of greenhouse environment control - temp., humidity, air circulation.

III. Examine plants closely (use hand lens). Is it pathological, entomological, physiological?

A. Pathological symptoms: (usually not uniform throughout greenhouse, specific for certain crops).

1. Necroti (dead) areas on roots, stems, leaves, flowers
2. Vascular - discoloration of veins, stem conducting tissue
3. Fungus or bacterial growth above or below soil level
4. Virus patterns - discoloration or modified growth - symptoms may resemble those caused by 2,4-D, ethylene, etc.
5. May require laboratory confirmation
6. Faulty (incomplete) soil pasteurization
7. Reinnoculation of soil through carelessness
8. Ends of hoses hung up.

B. Entomological symptoms:

1. Presence of insects on foliage, stems or roots

2. Signs of feeding (chewing, sucking or boring)

3. Old insecticides - faulty application schedules

4. Weeds under benches and outside air intake areas harboring insects

C. Physiological and cultural symptoms - utilize soil and foliar analysis if necessary (helps eliminate guess work).

1. Nutrient deficiencies

a.	Nitrogen	- light green or yellow foliage, more acute on lower leaves
b.	Phosphorus	- darkened, dull foliage color, sometimes purpling with yellowing in later stage; reduced growth
c.	Potassium	- chlorosis and or necrosis between veins working in from leaf margins
d.	Magnesium	- similar to potassium but leaf margins remain green
		- chlorosis of new growth with main veins remain green for a while
f.	Manganese	- foliar chlorosis but veins remain green forming a checkered pattern

   g. Boron - new growth hardens, becomes distorted and lateral growth develops

2. Nutrient toxicities

   a. Soluble salt accumulation - plants wilt when soil is moist, marginal leaf burn, chlorotic new growth, browning of roots
   b. Ammonium-nitrogen - wilting, chlorosis, root injury
   c. Nitrate-nitrogen - excessive vegetative growth followed by restricted growth at higher levels
   d. Potash, boron, manganese, zinc - necrotic leaf margins

3. Soil problems

   a. Poor drainage
   b. Poor structure - heavy soil
   c. Unfavorable Ph
   d. Too frequent or too infrequent watering
   e. Insufficient water applied to thoroughly wet the soil
   f. Cold soil

4. Chemical - insecticide, pesticide, other

   a. Excessive rates used
   b. Fumigation of greenhouse when foliage was wet
   c. Application at temps. above 80 - 85°F (especially fumigants)
   d. Application during prolonged dark periods when plants were soft
   e. Particular species or cultivars sensitive to particular chemical product
   f. Excessive quantity of wetting agent use - can occur from combining spray materials
   g. Weed killer residue in soil or volatile fumes
   h. Soil fumigant residue in soil

5. Climatic

   a. High or low temp. (including freezing injury - use temp. recorders)
   b. Wrong photoperiod - light interference - burned out light bulbs - faulty controls - holes in black cloth

6. Miscellaneous

a. Penta, creosote (wood treatment) injury
b. Fertilizer injector faulty
c. Faulty calculations of materials applied
d. Gas fumes from faulty burners, fresh manure, other pollution sources - mechanical projects (welding, gas engines)
e. Nematodes - plants grow to limited extent at intervals, may wilt, may develop lumps on roots
f. Dodder

REMEMBER

Consult with owner but don't overlook the grower and other individuals working with the crop. Always check root condition.

INFORMATION SHEET

SEEDING PROBLEMS AND TREATMENT

William H. Carlson
Michigan State University

Provided by Vaughn Jacklin Corporation

PROBLEM	POSSIBLE CAUSE	SUGGEST TREATMENT
Poor germination	Improper temperature	Check soil temperature. Be sure it agrees with proper germination temperature for variety.
	Improper moisture	Correct watering, improve practices.
	Lack of light	Some species require light to germinate, sow this type seed on top of soil.
	Damping off	Used steamed soil for germination or a synthetic soil that is sterile. Drench with fungicide (Dexon). Improve air circulation. Keep the germination area clean.
	High salts	Don't use soils that have been heavily fertilized. Leach.
	Methyl Bromide damage	Make sure treated soil is well aerated. Don't use on carnation or salvia plants.

SEEDLING PROBLEMS AND TREATMENTS

Continued

PROBLEM	POSSIBLE CAUSE	SUGGESTED TREATMENT
Poor seedling growth	Improper watering	Check to be sure soil is well drained, water thoroughly so that some leaching occurs. Don't let seedling stand in water.
	Lack of fertilizer	Seedlings will need nutrients, soil test to determine how much and when to apply.
Poor root growth	Lack of phosphorus	Apply superphosphorus to soil MIX or a phosphorus containing fertilizer.
Rotting seedling at soil line	Rhizoctonia	Apply fungicide (Terrchlor)
Wilting of seedling	High Salts	Check with solubridge. Leach!
	Improper watering	Water thoroughly.
Weak, spindly growth	Low light intensities	Don't keep in dark place for long periods of time.
	High temperature	Use proper growing temperature.
Curvature of leaves	Gas damage	Clean all burners and check gas lines to be sure there are no leaks.

To avoid these problems 1. germinate at proper temperature, 2. water properly, 3. use a sterlized soil MIX that contains proper nutrient levels., 4. germinate area that is clean and well maintained.

The best defense against these problems is a well planned growing program, plus knowing the proper growing practices and procedures to use.

Keep records of seeding practices and procedures. If you then have problems they will be easier to solve.

INFORMATION SHEET

"Problems that occur After Transplanting and Treatments" is a summary that was prepared by Dr. Jim Boodley of Cornell University and should be helpful in tracking down possible causes of trouble.

Provided by the Vaughn Jacklin Corporation

AFTER TRANSPLANTING PROBLEMS AND TREATMENT

PROBLEM	POSSIBLE CAUSE	SUGGESTED TREATMENT
Plants are off color, appear light green	Low nutrition High soluble salts	Apply complete liquid feed. Check total soluble salts level. Leach flats if salts are high.
	Too low temperature	Growing too cold. Use warmer temperature.
	Water-logged soil	Raise paks to improve drainage.
Chlorosis Interveinal Yellowing	Root injury due to several causes	Apply iron but also try to correct underlying cause.
	Improper soil pH	Soil test before using soil to make corrections.
	Overwatering Underwatering	Correct watering, improve practices.
	High soluble salts	Leach
	Herbicide residue	No control; investigate soil source before buying.
	Trace element deficiency	Apply trace elements
Uneven growth	Poor mixing of soil and fertilizer	Use liquid feed.
	Non-uniform feeding and watering due to uneven flats	Use straw, gravel or benches to get level platform.

PROBLEM	POSSIBLE CAUSE	SUGGESTED TREATMENT
	Non-uniform moisture levels at transplanting	Pre-wet containers at least 24 hours before use.
	High soluble salts	Leach
	Poor grading of seedlings	At transplanting select uniform sized plants for each pak.
Purple leaves of tomatoes and marigolds	Phosphorus deficiency	Soil test before using soil. Apply high phosphorus liquid feed.
	Grown too cold	Check night temperatures: avoid growing too cold.
Seedlings fall over	Damping off	Use steamed soil. Drench with fungicides. Improve air circulation.
Holes in plants	Slugs, snails, cockroaches	Use proper insecticides
Lower leaves rotting and drying	Botrytis Rhizoctonia	Improve air circulation Use termil for Botrytis Terrachlor for Rhizoctonia.
Slow growth	Low nutrition	Test soil, apply liquid feed.
	Grown too cold	Increase temperatures. Use 60° N.T. 2 to 4 weeks after transplanting.
	Grown too dry	Apply proper amounts of water.
	Herbicide present	Know soil history; avoid corn field soils.
Tall and spindly growth	Over fertilized with nitrogen	Test soil-check proportioner ratio.
	Grown too warm	Cool temperatures, harden plants, improve ventilation via fan.

PROBLEM	POSSIBLE CAUSE	SUGGESTED TREATMENT
	High natural temperature	Use B-9 at proper stage.
	Excess water	Avoid overwatering.
	Low light intensity	Keep glass clean, wash dust off plastic, paint woodwork white.

INFORMATION SHEET

INSECTS

Subject Matter Outline:

1. Characteristics of insects
    a. Major parts of insects
    b. Metamorphosis of insects
        (1) complete
        (2) incomplete
    c. Life cycles of insects

2. Types of insects
    a. Chewing insects
        (1) Insects on leaves and stems of plants
        (2) Chewing insects infesting seed and grain
        (3) Chewing insects that bore in stems and leaves
        (4) Chewing insects on roots and other underground parts of plants
    b. Sucking insects
        (1) Effect of sucking insects on plants
        (2) Parts of plants attacked by sucking insects
    c. Beneficial insects
        (1) Bees
            (a) Fruit pollinators
            (b) Alfalfa pollinators
        (2) Insects that parasitize other insects
        (3) Silk producers
    d. Injurious insects
        (1) Insects that damage plants
        (2) Insects that carry diseases

3. Control of insects
    a. Chewing insects
        (1) Stomach poisons
        (2) Break life cycle
        (3) Contact poisons
        (4) Seed and grain treatments
            (a) Dry grains
            (b) Treat seeds and grain
        (5) Control of borers
    b. Sucking insects
        (1) Contact poisons
        (2) Systemic controls
    c. Soil insects
        (1) Soil treatments (chemical)
        (2) Cultivation

4. Safety with insect controls
    a. Food and drug regulations
    b. Safety to the user

INFORMATION SHEET

DIAGNOSTIC CHECK LIST AND PLANT HISTORY

When definite reasons cannot be given for the poor growth of plants, it is usually because many facts have been overlooked. Although these facts may seem minor, they all help. The following questionnaire is designed to assemble this information. Because these questions may direct you to areas you have overlooked, when you answer them you may be able to diagnose the problem.

If you can't diagnose your problem alone, bring this completed form to the professional horticulturist of your choice, or to your County Extension Agent. Please attach additional comments as necessary.

I. Name and address of inquirer ______________________

____

II. Kind of plant __________ Variety of Cultivar __________

Approximate age of plant ___ Height ____ft.; width _____ ft. What month was th problem first noticed this year? __________ Has the trouble appeared in previous years? __________ What years? (list). ______________

III. Has plant recently been transplanted? ________ When? Month __________ Year __________. Is the plant considered winter hardy for your area? ______________

IV. Are other plants of the same kind nearby? ________ How near? ______________ Are they having the same trouble? __________ Is the plant in a location exposed to the wind? ______ the sun? __________

V. Have weed killers been used in the vicinity? __________

How near? ______________________

What chemical? ______________________

VI. Is there evidence of injury from lawn mowers, automobiles, machinery, animals, heavy pruning or faulty planting?

____

VII. Describe care given to plant in question for the past two or more years.

A. Fertilizer (kind and amount; foliar or soil application)

____

____

B. Insecticides-fungicides (kind; foliar or soil applicaton; systemic; liquid or powder concentrate) ______________

____

C. ____

D. Drought and winter protection ______________________

VIII. Comment on unusual weather conditions. (extreme temperatures, late or early frost, heavy wind, hail and ice storms, drought periods, excessive rainfall or flooding)

Present season: ______________________________

Previous season: ______________________________

IX. Do cement, asphalt or other types of pavement occur near the plant? __________ What type? ______________________

______________ How long has it been there? ____________

X. Are there gas, water, steam, sewer or other pipes or conduits in the ground near the plant? ________ Have tests for leakage been made? ______________________________

XI. Has plant been exposed to salt used for ice control along a street or highway or along walk ways? ________________ (A salty mist stirred up by auto traffic can cause foliar damage to conifers. A similar problem occurs along sea coasts following storms.)

XII. Soil in which the plant is growing.

A. How deep is the surface soil above rock, hardpan or subsurface layers of soil (soil layers may be detected by different color)? __________ inches.

B. Is the soil clay? ____ loam? ________, sand? __________

C. What is the internal drainage of the site? Good __________

Poor ____________ Excessive __________. (Good, poor or excessive internal drainage may be determined by the rate at which water disappears from a test hole. A hole may be dug to a depth of thee feet, filled with water and a record kept of the time required for water to disappear. Fill the hole with water three times and record the time of disappearance after each filling. If water remains in the test hole one or more days, drainage is poor and in need of improvement. If water drains away repeatedy in less than three minutes, drainage is excessive.)

XIII. Description of trouble:

A. Foliage (leaves, needles)

1. Off color? (spots, yellow, brown, etc.) __________

Describe ________________________________

____

2. Symptoms appear on upper leaf surface? __________

lower leaf surface? ______________________

3. Edges of leaves brown? ____________________

Edges of leaves tattered? ____________________

4. Deformed? (galls, twisted, rolled, blisters, callus, etc.) ________________________________

Describe ________________________________

____

5. Leaves wilted? ____________________________

6. Partially devoured by insects?* (holes, leaf mines, leaves chewed on peripheral area or interveinal)

__________ Describe ______________________

____

B. Twigs

1. Off color? Describe ________________________

2. Deformed? (swollen, lesions, cankers, galls, etc.)

______ Describe ______

______

3. Bark split? ______

4. Dark streaks in wood under bark? ______

5. Channels in wood or under bark? ______

Describe ______

______

6. Twig girdled by insects? ______

C. Flowers

1. Off color (spots on petals, etc.) ______

Describe ______

______

2. Deformed? Describe ______

3. Chewed by insect? ______*

D. Fruit (berries, pods, cones, etc.)

Off color? ______ Describe ______

______

Deformed? ______ Describe ______

Chewed upon or hollowed out by insect?* ______

(Describe insect as caterpillar, maggot, grub, beetle, etc.) ______

E. Trunk and Branches

1. Oozing sap or flow or resin? ______

Describe ______

______

---

*Collect insect specimens

2. Dark streaks in wood under bark? ______________

3. Discolored bark? __________ Swollen? ____________

Constricted? ______________________________

4. Evidence of insects under bark?* ______________

Remove dead bark and determine extent of injury.

Describe ________________________________

____

5. Patches of white fluffy material or any other foreign substance on bark? ________________________

6. Bark split? ______________________________

F. Roots

1. Are some roots exposed? ______________________

2. Have roots been covered with soil, sand or gravel?

______________ When? ___________ To what depth? ___________

3. Is there grass growing under the plant? _________

Is it mulched? _________ With what? ___________

4. Is there any unusual growt on the main stem at or just under the soil line? ____________________

Describe ________________________________

5. Were there any insects found after a few roots were exposed?* _____________ Were roots malformed?

____

---

*Collect insect specimens

Note: Sketches or photographs often help to present the facts in a given situation and sometimes furnish valuable clues.

STUDENT WORKSHEET

BEING A PLANT PEST DETECTIVE

Directions: Use this list to help you remember those things which indicate that the plant is unhealthy.

Kind of plant ____________________ Location ______________________________

Question	Yes or No	Description of Symptom
1. Is any part of the plant broken, damaged or leaking sap?		
2. Is the plant wilted?		
3. Is the plant stunted or not developing a normal shape?		
4. Is any part of the plant rotted?		
5. Is any part of the plant yellowish, brownish, or of a color different from the usual?		
6. Are there any unusual growths on the plant?		
7. Can you spot any pests?		

I have filled in all the plant symptoms I can see.

Name ___________________________________

STUDENT WORKSHEET

INSECT REPORT OUTLINE

The purpose of this insect report is for you to systematically identify in depth an insect; understand its life and its habits. After your study of the insect, you should be able to recommend possible controls for this pest. This step method approach should become common practice whenever considering controls for other insect pest in the future.

INSECT

CHEMICAL - Recommendation from 1981 Handbook

1. Description of insect

   Include the scientific information necessary to identify the insect

2. Describe the areas over which the insect may be found--its distribution
3. Describe the area over which an individual of the species may roam or forage - its range
4. Indicate the host and alternate hosts the insect has, their distribution and numbers
5. Describe the characteristic damage of the pest on different hosts
6. Describe the habits of the insect
   - a. Individual history (life cycle)
   - b. Generation span
   - c. Individuals per year
   - d. Vectors
   - e. Resting sites and times
   - f. Hibernation (over winter) sites and times
   - g. Oviposition sites and times
   - h. Eating habits - when, where, how

7. Factors that cause the insect to become destructive

8. Possible controls

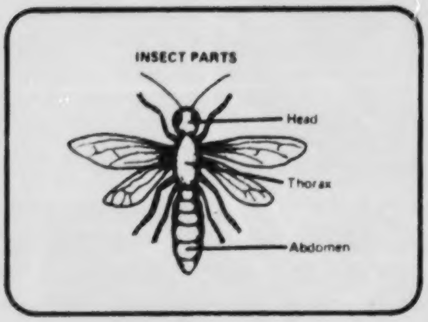
    a. Indicated by bionomics
    (There may be several possible methods; outline the one that appears best)

    b. Through the use of chemicals - Outline one chemical and its activity. Check with the instructor before.
    (Include the best places and times of application as a reult of bionomic study)

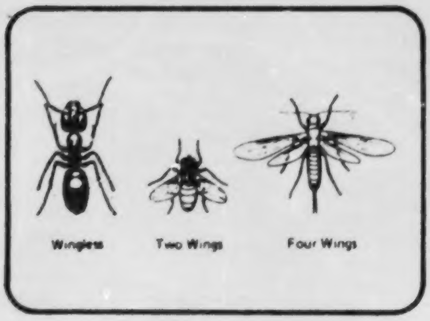
9. Indicate references used. Site sources of specific information.

TRANSPARENCY STUDY GUIDE

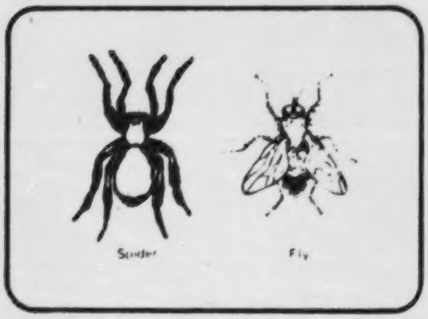
IDENTIFYING COMMON INSECT PESTS


INSECT PARTS
Head
Thorax
Abdomen

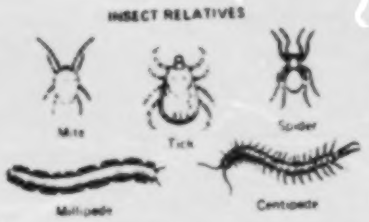
An adult insect may be defined as a small invertebrate animal with three body regions and six jointed legs.


Wingless
Two Wings
Four Wings

It may be wingless, or have two or four wings.



Insect relatives are animals closely related to insects but have two body regions, eight or more jointed legs, and wingless.



Insecticides are only one of many pesticides used in controlling pests. They are used to control insects and "Insect Relatives," such as mites, ticks, spiders, millipedes, and centipedes.

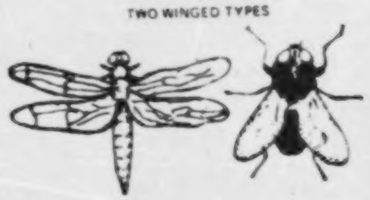
Many insect problems are solved by natural controls; however, pesticides usually provide quicker control action.

More than 95 percent of our insect problems are solved by natural control, such as weather, predatory animals, and parasitic plants and animals. But because of the problems that nature does not solve, or because it is slower than we like, other control actions are necessary.

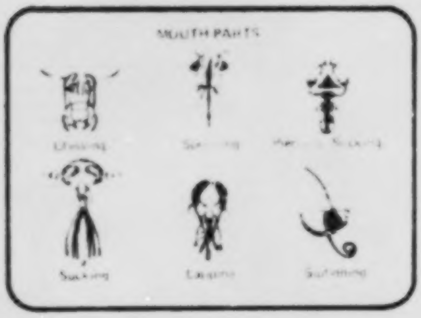
Other means of control are good housekeeping or sanitation practices, crop rotations, mechanical control (fly swatters), traps, baits, biological controls, and chemicals.

Identifying Insects and Insect Relatives

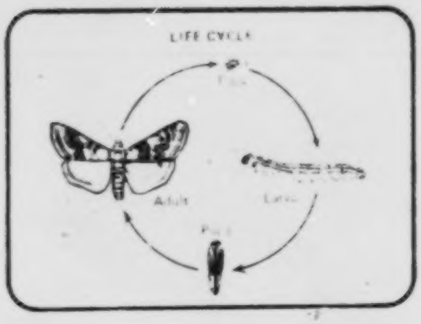
Before selecting and applying any chemical, be sure you can accurately identify the insect and understand its life cycle. Occasionally you can avoid or at least reduce the destruction by some pests without using an insecticide, but for most insects you must rely on an insecticide to provide the satisfactory management that you want.



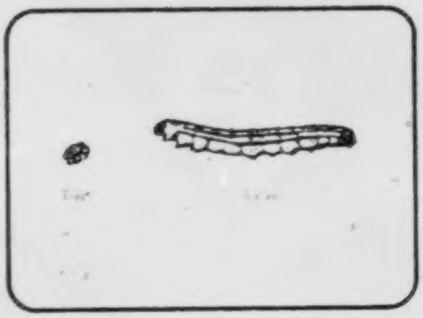
You can tell one insect from another by looking at the **wings** and **mouthparts**. As previously mentioned, some insects have no wings, whereas, others have two or four. The wings vary in shape, size, thickness, and structure.


MOUTH PARTS
Chewing
Sponging
Piercing-Sucking
Sucking
Lapping
Siphoning

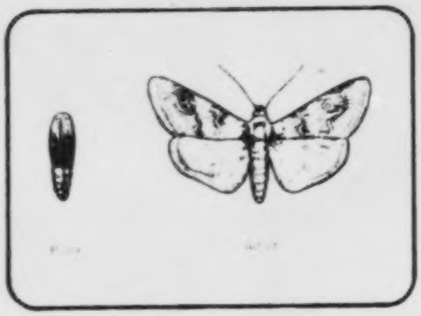
Insects also feed in different ways. Those with chewing mouthparts have toothed jaws that bite and tear the food. Insects with piercing-sucking mouthparts have a long beak which they force into a plant or animal to suck out fluids or blood.


LIFE CYCLE
Egg
Adult
Larva
Pupa

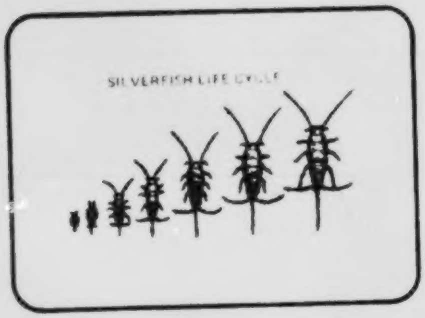
Almost all insects change in shape, form, and size during their lives. This change is called metamorphosis. In general, insects develop from eggs in two different ways. One group is said to have a "complete life cycle" and goes through four stages of development.



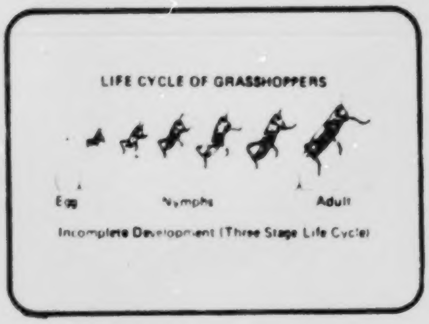
The **larva** hatches from an **egg.** It is a worm, caterpillar, grub, or maggot. This is the stage in which these insects grow the most and do the most damage.



When full-grown, the **larva** changes into a **pupa**. After this stage it changes into an adult. The adult stage usually has wings.

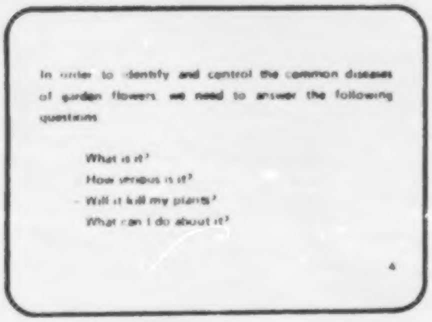

SILVERFISH LIFE CYCLE

The other group of insects has only three development stages. This is called an "incomplete life cycle." The adult lays **eggs** and a **nymph**, which looks like a tiny adult, hatches from the egg and goes through several growth stages. These **nymphs** change into wingless **adults.**


LIFE CYCLE OF GRASSHOPPERS
Egg
Nymphs
Adult
Incomplete Development (Three Stage Life Cycle)

Some insects change form slightly. Their nymphs, which have no wings, go through several growing stages. They change into winged adults.

DISEASES OF GARDEN PLANTS AND VEGETABLES

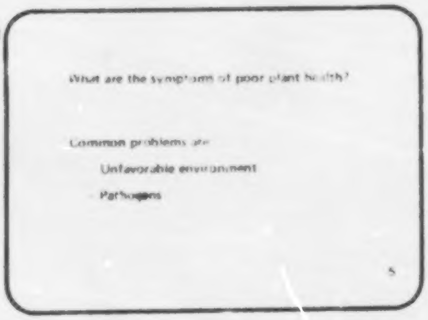


In order to identify and control the common diseases of garden flowers, we need to answer the following questions:

- What is it?
- How serious is it?
- Will it kill my plants?
- What can I do about it?

Garden flowers, like all plants, are affected by many different kinds of diseases. The purpose of this slide set is to provide the information needed for the identification and control of the common diseases of garden flowers.

The first question, "What is it?" is known as disease diagnosis. Correct diagnosis is necessary before proper control measures can be suggested. As you look at a plant, ask yourself if the growth is normal and healthy. If not, what are the symptoms of poor health?



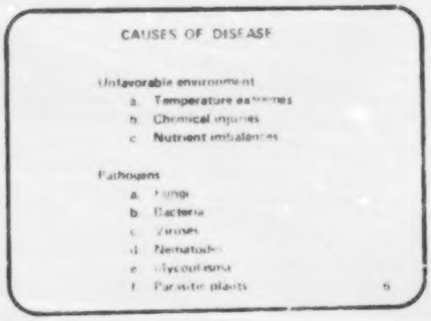
What are the symptoms of poor plant health?

Common problems are:

- Unfavorable environment
- Pathogens

Symptoms are the result of a disease-inducing factor. In some cases these factors are unfavorable environmental conditions such as extremes in temperature, water, light or essential plant nutrients. If some environmental condition is the cause, a number of different kinds of plants growing in the same area usually show similar symptoms at the same time.

In other cases, diseases are caused by agents called pathogens that can spread from plant to plant and incite infectious diseases. Infectious or parasitic diseases are usually quite specific, and only one or a few closely related species of plants in an area are infected by a given pathogen.



CAUSES OF DISEASE

Unfavorable environment

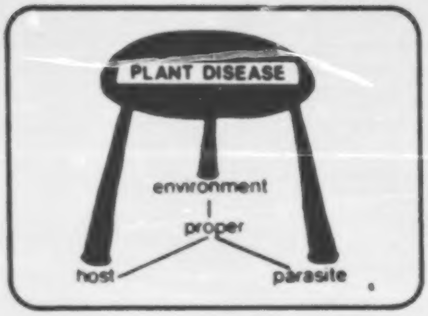
a. Temperature extremes
b. Chemical injuries
c. Nutrient imbalances

Pathogens

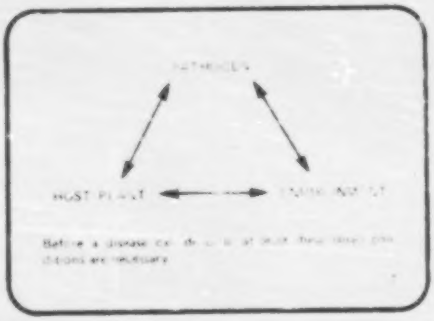
a. Fungi
b. Bacteria
c. Viruses
d. Nematodes
e. Mycoplasma
f. Parasitic plants

Plant diseases may then be divided into two major groups: those caused by unfavorable growing conditions and those caused by pathogens. It is important that these two groups be distinguished.

A plant disease is any condition which causes abnormal plant development. Plant diseases are most often infectious, spreading from plant to plant. Diseases may also be non-infectious, such as injury caused by weather conditions, air pollution, or deficiency and excess of water or nutrients.

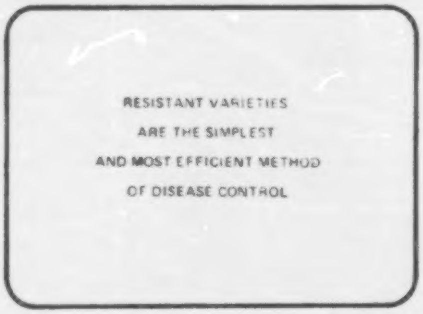


Three factors are necessary before an infectious disease can occur. These are: (1) susceptible host plant; (2) a favorable environment; and (3) a casual organism.



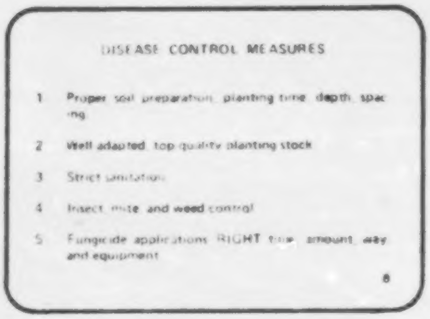
Before a disease can develop at least these three conditions are necessary

Effective disease control measures are aimed at breaking this pathogen-host-environment triangle. For example, the plant can be made less susceptible by breeding a resistant variety. The environment can often be changed to be more favorable for the growth of the host plant and be less favorable for the development and spread of the pathogen. Finally, the pathogen can be killed or prevented from reaching the host plant. These basic methods of control can be divided into numerous cultural and chemical practices to keep diseases in check.



RESISTANT VARIETIES
ARE THE SIMPLEST
AND MOST EFFICIENT METHOD
OF DISEASE CONTROL

Use of resistant varieties, as already mentioned, is the simplest and most efficient way to avoid disease problems. Many disease agents are quite specific as to which hosts they will attack. For example, organisms which cause diseases of the cabbage or cucumber family rarely if ever attack members of the tomato family.

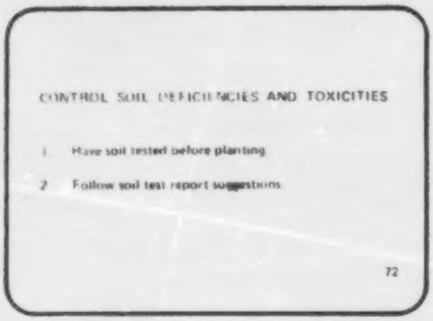


DISEASE CONTROL MEASURES

1 Proper soil preparation, planting time, depth, spacing
2 Well adapted, top quality planting stock
3 Strict sanitation
4 Insect, mite, and weed control
5 Fungicide applications RIGHT time, amount, way and equipment

Well-adapted, vigorously growing flowers that are planted properly, fertilized, watered, and otherwise cared for are best able to withstand disease and insect attack. Cultural practices that are very helpful include proper preparation of the seedbed and planting at the proper time, depth, and spacing. This information is usually given on the package label and can also be obtained from your local florist or nurseryman. Plant only flower species and varieties that are well adapted to the area. Selecting and planting only top quality seed and planting stock easily pays for itself. Like anything else, you usually get what you pay for. Be suspicious of advertised "outlandish bargains" in newspapers or magazines; you may be buying diseased planting stock.

Sanitation is also an important control measure. This means promptly collecting and destroying infected plants and plant parts as they appear. Gather all plant refuse at the end of the season and burn or compost this debris. Follow a planting scheme that does not allow closely related annual flowers to grow in the same spot in consecutive years. Follow current insect, mite, and weed control practices suggested by your local teacher or county extension adviser. Your county extension office can also supply you with a wide selection of USDA circulars and leaflets plus the latest information on plant pests and their control from extension specialists at the University of Illinois or other land grant universities. Other plant experts in a community that would be willing to help include knowledgeable florists, nurserymen, gardeners, garden supply dealers, and personnel of nearby arboretums and botanical gardens.



CONTROL SOIL DEFICIENCIES AND TOXICITIES

1. Have soil tested before planting
2. Follow soil test report suggestions

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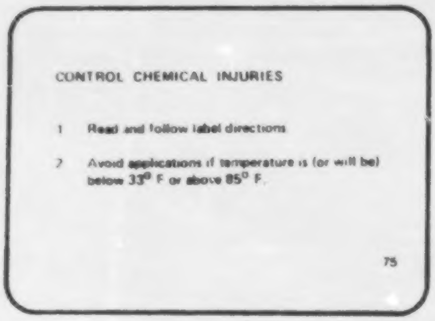
Fertilizers should be applied based on a soil test. Your instructor or county extension office can advise you where this service is available locally. They can also tell you how to take soil samples, plus supply you with soil test forms and mail tubes or boxes. Only by a soil test report, can you know exactly what essential elements your garden flowers need. Follow the suggestions as given in the soil test report.

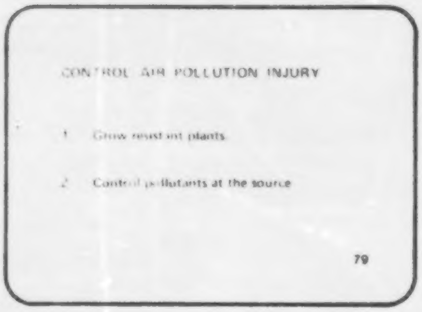


CONTROL CHEMICAL INJURIES

1. Read and follow label directions
2. Avoid applications if temperature is (or will be) below 33^{0} F or above 85^{0} F.

75

Chemical injuries can be kept to a minimum if you and your neighbors will read and follow all label directions on the pesticide container. Apply all chemicals at the suggested concentration, in the right way, at the right time, and to the right plants. There is little excuse for practically all pesticide injuries. Spraying should not be attempted when the temperature is below 33^{0} F. or above 85^{0} F. or is expected to reach these figures in the next 12 to 24 hours.



CONTROL AIR POLLUTION INJURY

1. Grow resistant plants
2. Control pollutants at the source

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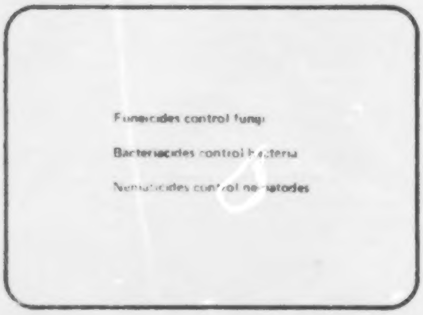
Injuries due to air pollutants are reduced by growing more tolerant or resistant plants. We will see even more resistant varieties in the future as the result of plant selection and breeding programs now in progress. Scientists have also noted that sprays of certain chemicals are partially effective in protecting plants against air pollutants. The use of control devices on motor vehicles, aircraft, industry stacks and combustion chambers, as a result chiefly of federal and state legislation, is also having a positive effect on the environment.

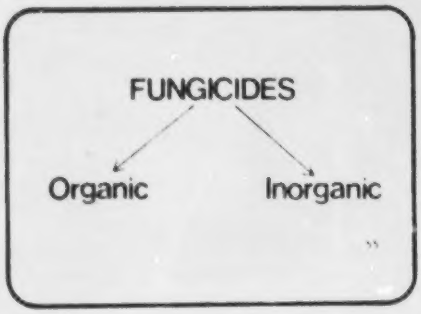


Fungicides control fungi

Bacteriacides control bacteria

Nematicides control nematodes

When fungicides, bactericides, or nematicides are used for control of disease, special application methods and adherence to safety precautions are necessary. A fungicide is a chemical which kills or inhibits fungi, and is the most common chemical control for the garden.

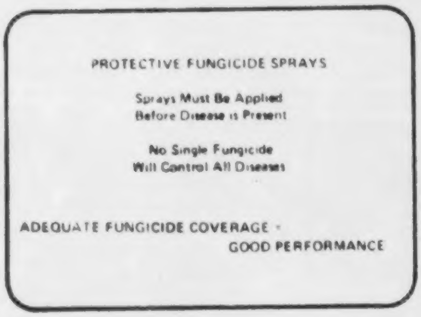


FUNGICIDES

Organic

Inorganic

Fungicides may be used as a dust or a spray. Sprays are preferable for disease prevention in home gardens. Fungicides may be classified as either inorganic copper fungicides (including bordeaux mixture) or organic fungicides.



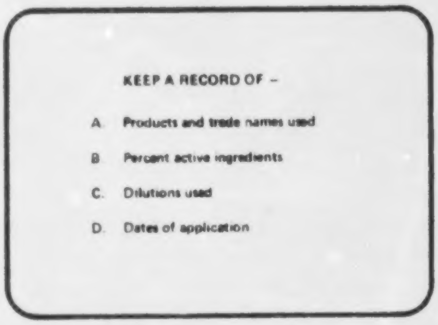
PROTECTIVE FUNGICIDE SPRAYS

Sprays Must Be Applied
Before Disease is Present

No Single Fungicide
Will Control All Diseases

ADEQUATE FUNGICIDE COVERAGE =
GOOD PERFORMANCE

Protective fungicide sprays: (1) sprays must be applied before disease is present, (2) no single fungicide will control all diseases, and (3) adequate fungicide coverage equals good performance.



KEEP A RECORD OF –

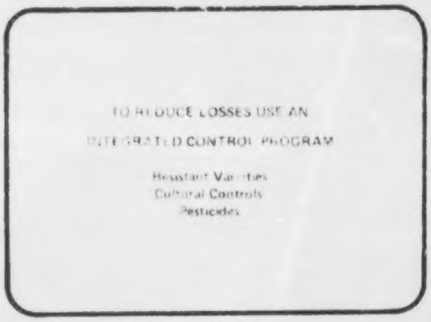
A. Products and trade names used

B. Percent active ingredients

C. Dilutions used

D. Dates of application

To assure safety, keep a record of the products and trade names used, the percent of active ingredients, dilutions, and dates of application.



TO REDUCE LOSSES USE AN

INTEGRATED CONTROL PROGRAM

Resistant Varieties
Cultural Controls
Pesticides

Solving most disease problems in the garden is a simple matter of

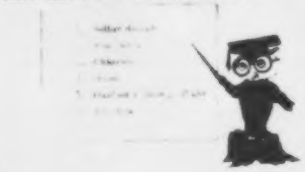
- identifying the pest
- knowing and using the best control methods available

An integrated control program of resistant varieties, good cultural practices, and pesticide application is best for reducing losses.

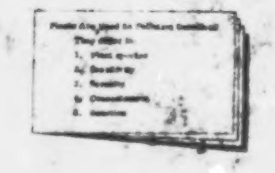
AIR POLLUTION DAMAGE TO VEGETATION

Plants--the very foundation of life provides humans with food, shelter, clothing, fiber, medicines, and the essential oxygen we breathe. Without plants there would be no life on earth. The plants which are so necessary to our being are now suffering from our presence. Many technological advances have resulted in injury to virtually all types of plant life. In North America, pollution has affected plants from the citrus groves of California and Florida to the pine forests of the East, West, and Canada. It is estimated that the United States annually loses more than $650 million to pollution and its effects on turf, shrubs, trees, vegetables, fruits, and field crops. Pollution in and around certain big cities has caused truck farmers, especially those growing leafy crops (such as lettuce and spinach), to move elsewhere.

MAJOR AIR POLLUTANTS

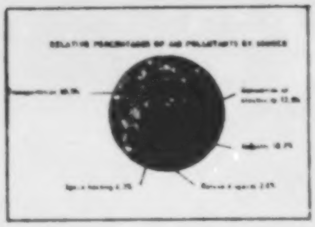


Sulfur dioxide, fluorides, chlorides, ozone, PAN, ethylene, ammonia, herbicides, mercury, carbon monoxide, hydrogen sulfide--all these can be air pollutants. The effects of these gaseous chemicals on paint, cloth, rubber, glass, metals, stone buildings, and similar materials may indicate their presence. Among the most sensitive detectors is the green plant.



Plants as pollution detectors

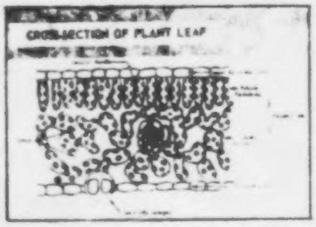
1) Plants can respond to the presence of air-borne contaminants. Depending upon the plant species and the pollutant, some may react to concentrations in the range of less than 1 part per billion (ppb) parts of air.
2) Plants sensitive to pollution are widely adapted and, thus, can determine the distribution of certain air pollutants. Sulfur dioxide and ozone damage have been traced to a source 30 miles or more away.
3) The severity of symptoms may be directly related to the concentration of the pollutant. Chronic and acute reactions are known for most pollutants.
4) The parts of the plant that show symptoms may also collect and concentrate the pollutant. These plant parts can later be chemically analyzed to determine which pollutant is causing the problem.
5) Plants differ in their reaction to pollutants (sensitive or resistant) and are classified accordingly. It is, then, possible to make a direct identification of the plant problem on the basis of the species affected and the symptoms expressed. Where does pollution come from?



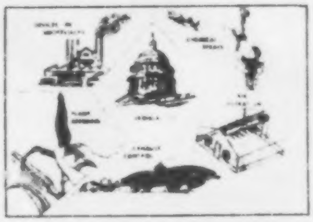
Color wheel. Some 200 million tons of air pollutants are released over the U.S. each year. This pie-shaped chart illustrates the relative percentages of air pollutants by source. Industry's contribution has been decreasing since 1963 while transportation's contribution has been increasing.

Plants may be injured by air pollution.

The kind, concentration, distance from the source, and length of exposure to the pollutant, as well as meteorological conditions, control the extent of plant damage.



Pollutants gain entry to the plant through leaf stomates (pore spaces on the lower leaf surface) or by chemically destroying tissue, both internally and externally. Why certain pollutants concentrate in and destroy specific tissues is largely unknown.



Control - In summary, we can control air pollution.

1) Proper legislation on all levels--national, state, and local--as well as its enforcement, should be insisted upon.
2) The problem should be eliminated at its source--internal combustion engine, filtering, or electrostatic devices in industrial plants, etc.
3) Plant breeding and selection is currently making excellent progress.
4) Many pollutants can be filtered from the air (for commercial greenhouses).
5) Commercial protectant sprays like ascorbic acid (Ozoban); or fungicides like zineb, maneb, ferbam, and thiram; calcium chloride, or calcium oxide; can be applied to protect plants from air pollutants.

SAFE USE OF PESTICIDES

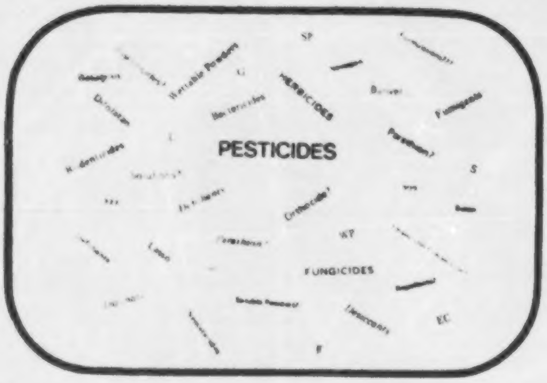
Safe Use of Pesticides

The use of pesticide products on farms, in the home and garden, and in commercial establishments, has brought many benefits to all of us. Their use on farms, ranches, and orchards is largely responsible for the abundant production of food and fiber which we enjoy today. Pesticide use has also improved the quality of the products we produce.

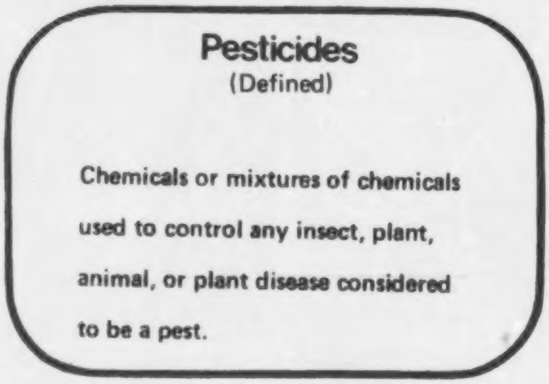
Pesticides, used properly and with restraint, are marvelous tools for man. If used carelessly, however, they may become dangerous poisons, harming you, your neighbors, children, livestock, and wildlife.

Protecting man and the environment from the hazards of pesticides is the responsibility of the U.S. Environmental Protection Agency, or EPA.

New laws have been enacted to see that this responsibility is carried out. As of October 21, 1977 all pesticide producers and users were required to follow stricter standards than in the past. This study guide will discuss those standards and offer additional suggestions for the SAFE USE OF PESTICIDES.



Before you can use--or even purchase--a pesticide product, you need to know exactly what you are about to use. There are various types and formulations from which you may choose. Any misunderstanding on the part of the applicator can lead to disappointment and disaster.



Pesticides
(Defined)

Chemicals or mixtures of chemicals used to control any insect, plant, animal, or plant disease considered to be a pest.

A pesticide, first of all, is some chemical or mixture of chemicals used to control any insect, plant, animal, or plant disease considered to be a pest. There are several types and subdivisions of pesicides that are available.

Types of Pesticides

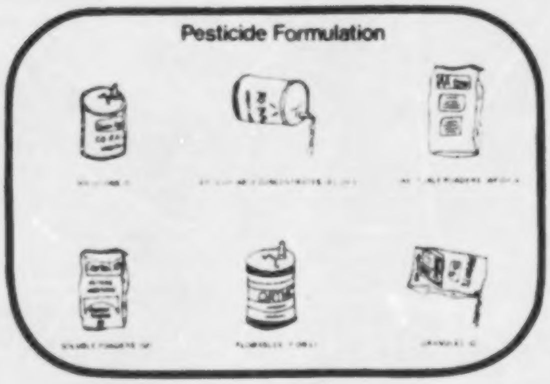
1. Insecticides
2. Fungicides
3. Herbicides
4. Rodenticides
5. Nematicides
6. Defoliants & Desiccants
7. Bactericides
8. Miticides
9. Repellents & Attractants

Too often, the word "insecticide" is confused with the word "pesticide." As you can see from this list, insecticides are only one type of pesticide.

Insecticides control insects and insect relatives; **fungicides** prevent and control fungi that cause plant disease; **herbicides** control weeds; **rodenticides** control rats, mice, and other rodents; **nematicides** control nematodes; **defoliants** and **desiccants** are called harvest-aids--defoliants cause leaves to drop prematurely, while desiccants cut through the skin of insects or leaf surfaces of plants, and cause tissue to dry out.

There are also **bactericides**, which control bacterial disease; **miticides**, which control mites; and **repellants** and **attractants**, which are used to drive a pest from, or lure a pest to, a certain location.

Pesticide Formulation



Some of the formulations available are:

Solutions (abbreviated by the letter "S"), which completely dissolve when added to the spray tank and will not clog equipment.

Emulsifiable Concentrates (EC or E) are liquid formulations that, when mixed with water, form a "milky" emulsion. Little agitation is necessary.

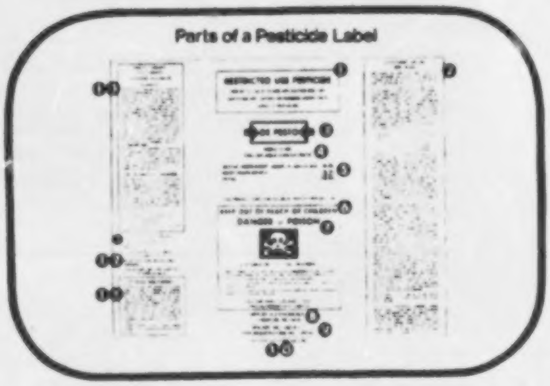
Wettable Powders (WP or W) are dry formulations. Strong agitation is needed to keep them in suspension.

Soluble Powders (SP) are like wettables, except they completely dissolve when added to water.

Flowables (F or L) are wettable powders sold as thick liquids to make them easier to add to water.

Granules (G) are applied directly to the soil or plants and are usually safer to apply than other formulations.

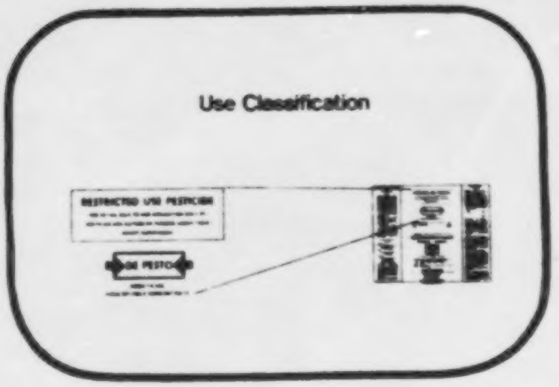
Parts of a Pesticide Label



When choosing and using a pesticide formulation, always read the label on the container. A pesticide label will contain the following information.

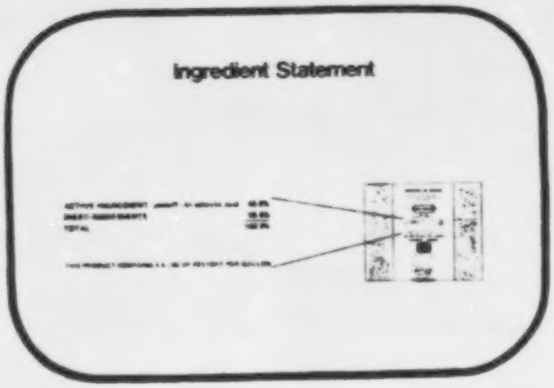
1. A "general" or "restricted" use classification statement.
2. Directions for use and the number of days to harvest or slaughter.
3. The brand or trade name.
4. The type of pesticide and the kind of formulation.
5. The name and amounts of all active ingredients.
6. The words: "Keep Out of Reach of Children."
7. The signal words.
8. Name and address of the chemical company.
9. EPA registration and establishment numbers.
10. The net content.
11. Storage and disposal precautions.
12. The reentry interval, if applicable.
13. Hazard or precautionary statements.

Let us look just a little closer at some of the label information.

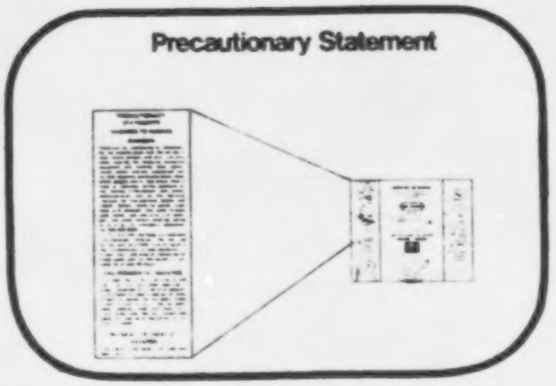

Use Classification

Every pesticide label shows whether the contents are for general use or restricted use. If a pesticide will do little or no harm to the applicator or the environment, it will have a "general use" classification.

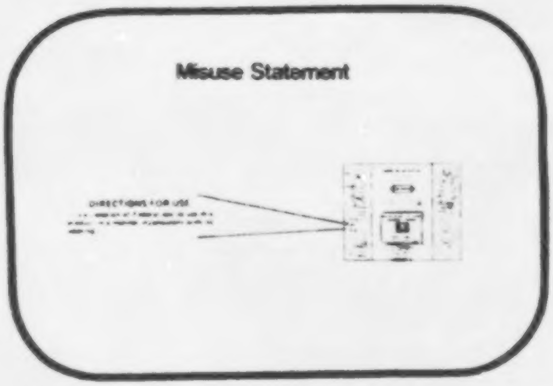
Restricted use pesticides are those which, even when handled and applied as directed on the label, could cause damage to the environment or to the people using it. These pesticides may be applied only by someone who is certified, or under a certified person's supervision. To be certified, both private and commercial applicators must meet state requirements.


Ingredient Statement

The chemical that is toxic to the pest is listed as the percent (or pounds) of active ingredient in the formulation. Inert ingredients (inactive) do not need to be identified except by the percent of the formulation that they constitute.

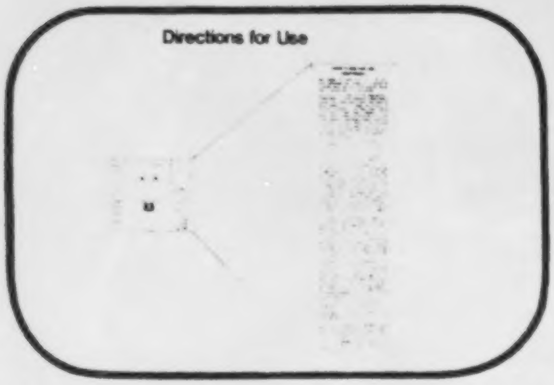

Precautionary Statement

The pesticide label contains precautionary statements concerning hazards to the applicator, children, domestic animals, wildlife, and the environment. First aid treatments, precautions to avoid injury, and warnings as to whether the pesticide is flammable, will appear on the label.


Misuse Statement

Pesticides may be used only as the label directs, except where special federal regulations specify use at a lower rate than recommended.

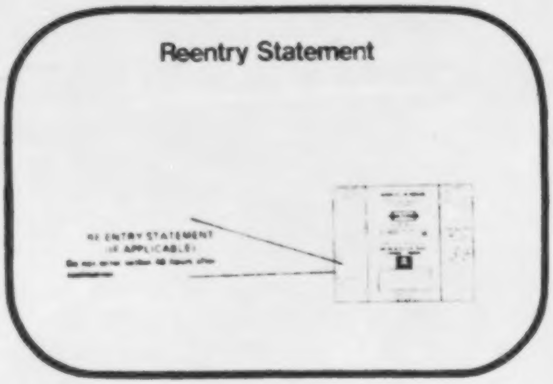
If you violate the federal law, you are subject to a $5,000 fine for each offense. Criminal penalties can be as much as $25,000 or one year in prison--or both.



Directions for Use

One of the most important parts of the label is the "Directions for Use" section. Application should never be left to guesswork or estimation. The directions must be heeded strictly, or severe harm could result.

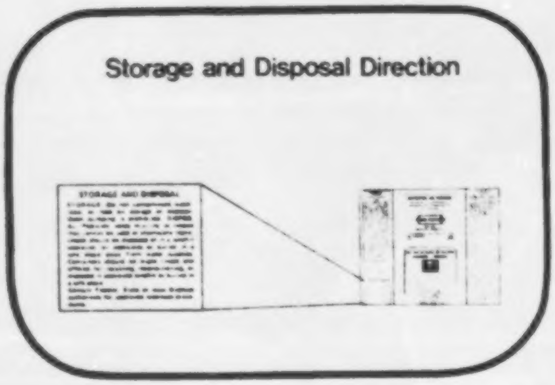
Improper application could cause harm to you, your family, your crop and livestock, and the environment. Besides, improper application is against the law.



Reentry Statement

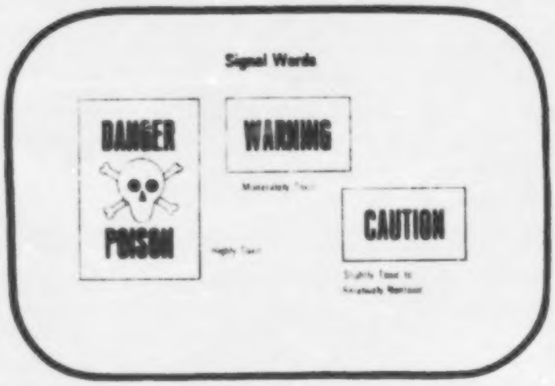
Immediately after applying a pesticide, it may be dangerous to reenter the field or area for a certain length of time. Always check the label for the reentry statement.

Remember, the spray that kills bugs and disease can hurt you, too.



Storage and Disposal Direction

The label will tell you how to store and dispose of your pesticide container. Make sure you read the label! Some types of disposal methods are prohibited for certain pesticides. Check labelling recommendations for where and how to store the pesticide; how to decontaminate and dispose of the pesticide container; plus how and where to neutralize and dispose of surplus pesticides.



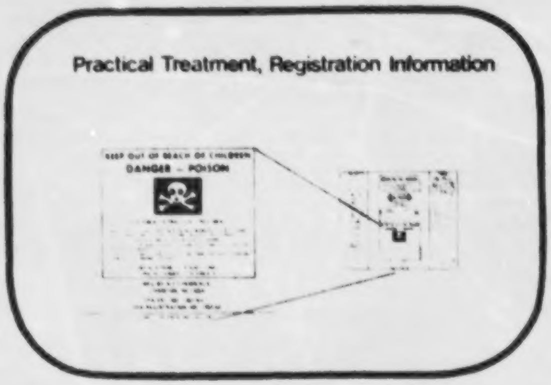
Signal Words

The signal words found on labels are important guides to the relative toxicity of the pesticides you are using.

DANGER means the pesticide is highly toxic; the word poison printed in red and the skull-and-crossbones symbol are also required on labels of highly toxic pesticides. (For example, a highly toxic insecticide would be Dyfonate).

WARNING means the pesticide is moderately toxic. (An example of a moderately toxic herbicide is Ramrod).

CAUTION written on a label means the pesticide is slightly toxic to relatively nontoxic. (Banvel would be an example of a slightly toxic herbicide.)

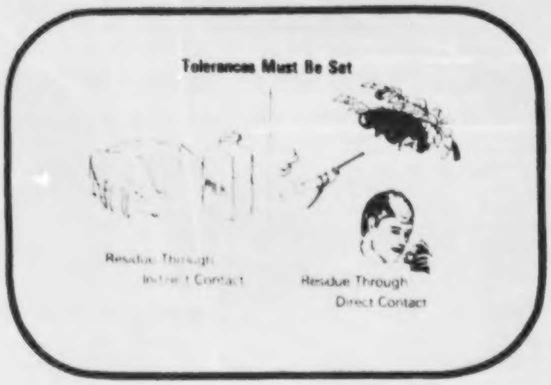


Practical Treatment, Registration Information

KEEP OUT OF REACH OF CHILDREN
DANGER — POISON

The label will always tell you to keep the pesticide out of the reach of children. Do not forget to obey this warning. The label will usually contain a statement of practical treatment, also. It will give the directions for the proper action to be taken if the pesticide is swallowed, inhaled, or contacted with the eyes or skin.

If there are problems or questions, the manufacturer's name and address appear on the label. In addition, the company registration and establishment numbers are listed, should you need to contact the Environmental Protection Agency. They prove that the company is legitimately registered. It is against the law to use a pesticide which has not been registered.

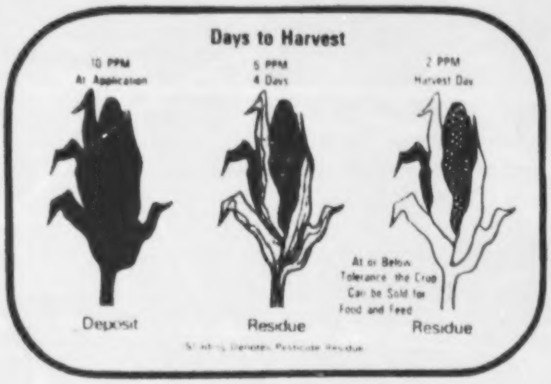


Tolerances Must Be Set

Residue Through Indirect Contact
Residue Through Direct Contact

As mentioned earlier, the label will tell you how much pesticide to apply. The rates of application are determined through tests on tolerance. To determine tolerance levels, studies are done on test animals and crops to find the acute (or immediate) and the chronic (or gradual) toxicity of the chemical. Then, the length of time the pesticide remains on the target crop or animal is measured. A possible long-term injury, such as build-up in man or animals, is studied.

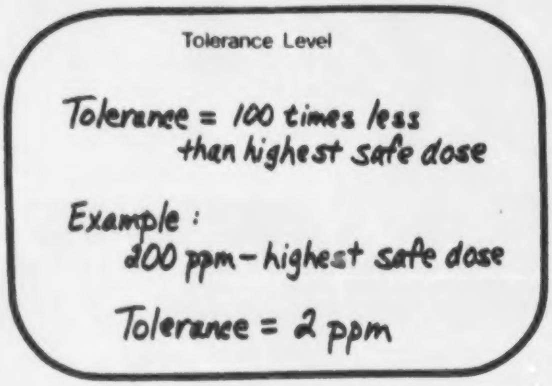
All food or feed which contains even a tiny amount of pesticide residue at harvest or slaughter must have a tolerance. A residue in food or feed may be the result of direct or indirect contact with the pesticide.



Days to Harvest

10 PPM
At Application
5 PPM
4 Days
2 PPM
Harvest Day
At or Below Tolerance the Crop Can be Sold for Food and Feed
Deposit
Residue
Residue
Stippling Denotes Pesticide Residue

Since residue amounts are determined and safe tolerance levels are set, you can check the label to find the least number of days between the last pesticide application and the time for harvest (or slaughter). Harvest or slaughter should not be attempted before the time period is over. When the food or feed is at or below tolerance, it may be sold.



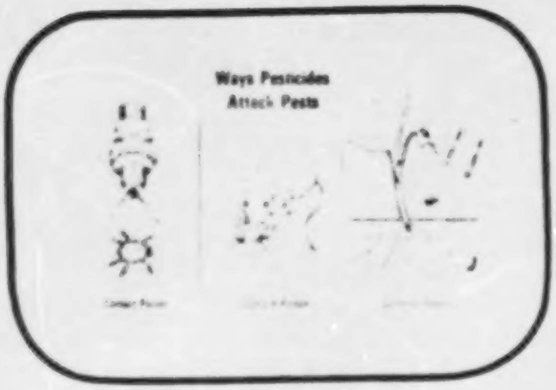
Tolerance Level

Tolerance = 100 times less than highest safe dose

Example :
200 ppm – highest safe dose

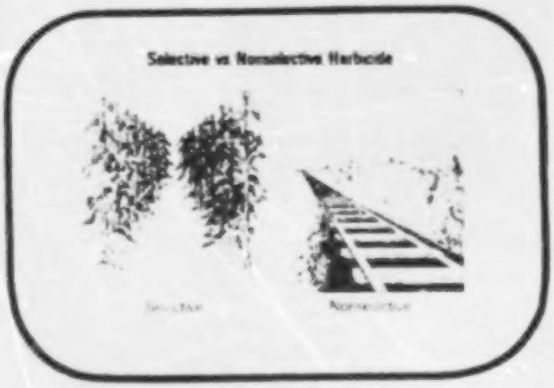
Tolerance = 2 ppm

Tolerance is always set at least 100 times smaller than the highest dose which has no effect on test animals. For example, if 200 parts per million (ppm) of a pesticide have no effect on test animals, then the tolerance for the pesticide on any food or feed crop can be no higher than 2 parts per million. Food or feed which is intended to be eaten must be below the tolerance level.

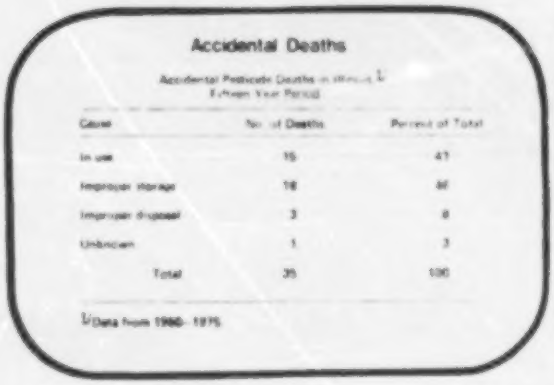


Pesticides attack pests in a variety of ways:

1. **Contact Poison** is used as a surface spray, dust, or in soil incorporation, and has to touch or be touched by the pest.
2. **Stomach Poison** is used as a bait, spray, or dust and has to be eaten by the pest.
3. **Systemic Poison** is used as a surface or foliar spray, pour-on, injection, or granule. The systemics may be absorbed, injected, or fed into the plant or animal to be protected. When the pest feeds on this plant or animal, it eats the systemic chemical and is killed.
4. **Fumigant Poison** is applied as a gas or as a liquid, which then vaporizes.



One type of pesticide which can be classed into two groups is herbicides. They can be selective or nonselective. A nonselective herbicide would be used to kill all plants in the area, while a selective herbicide is used to kill some plants, with little or no injury to other plants in the same area.



Accidental Deaths

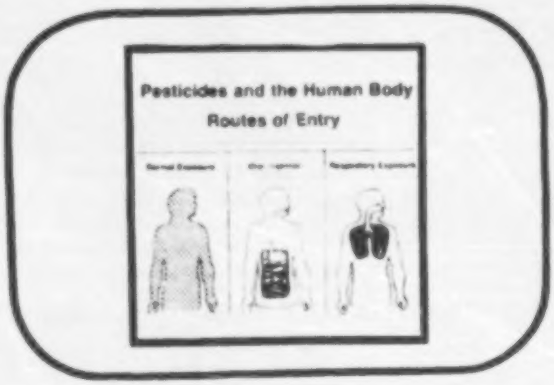
Accidental Pesticide Deaths in Illinois 1/
Fifteen Year Period

Cause	No. of Deaths	Percent of Total
In use	15	43
Improper storage	16	46
Improper disposal	3	8
Unknown	1	3
Total	35	100

1/ Data from 1960–1975

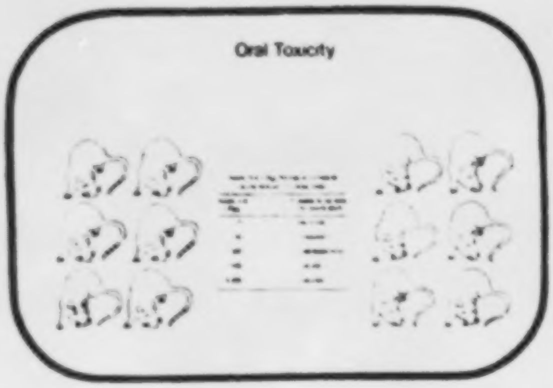
In a recent 15-year period, 35 people have died in Illinois from pesticide poisoning. The larger percentages of death occurred when people were not careful in using the pesticide and when they did not store the pesticide properly. Each year in Illinois, about 680 children under the age of twelve are treated for ingestion of pesticides, mainly because the chemicals were not locked in a safe place, out of reach.

They account for only six percent of child ingestion cases, ranking below medicine (59.8%) and household preparations (13.3%), but you should always treat pesticides as potential poisons. It should be noted that agriculture has a good record--only one of the 35 deaths occurred from pesticides used on the farm. Let us work to keep agriculture's record a good one.



When working with pesticides, you are being subjected to various kinds of exposure. Before a pesticide can harm you, it has to enter your body:

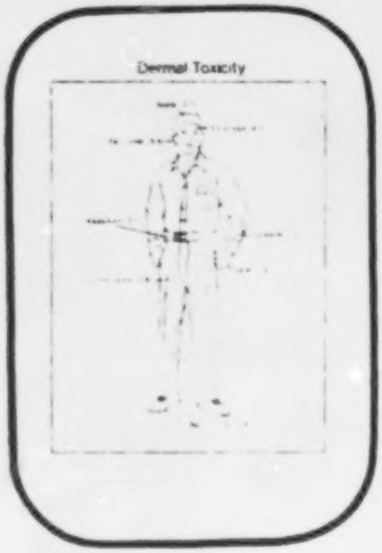
orally — through the mouth and digestive system;
dermally — through the skin;
inhalation — through the nose and respiratory system.



Acute oral toxicity is expressed by the LD_{50} value. LD_{50} refers to the dosage which kills half of a large group of test animals. (LD means lethal dose). If you know the LD_{50} of a pesticide, you can estimate the amount likely to cause death (the probable lethal dose) by referring to the ratings in this transparency.

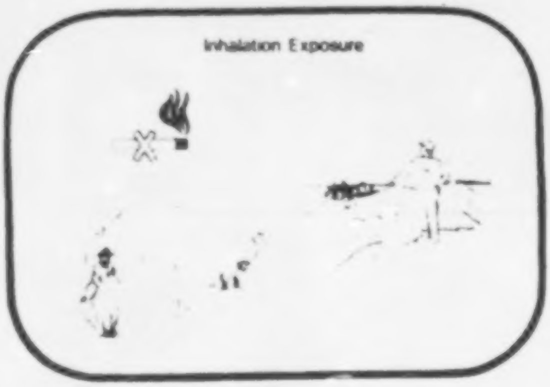
The ratings range from extremely hazardous to slightly hazardous. The probable lethal dose for a 150-pound adult varies from a few drops to more than two pounds. Therefore, the lower the LD_{50} number, the more lethal the pesticide.

Some examples of highly toxic chemicals would be the insecticides Temik (aldicarb) which has an oral LD_{50} of 5 to 10; and Thimet (phorate) which has an oral LD_{50} ranging from 1 to 3. Those which are somewhat less toxic are Sevin (carbaryl) with an LD_{50} of 500 to 850; Malathion (malathion) with an LD_{50} of 1000 to 1,375; and Marlate (methoxychlor) with an LD_{50} of 5,000. The herbicide AAtrex (atrazine) has an LD_{50} of 3,080.

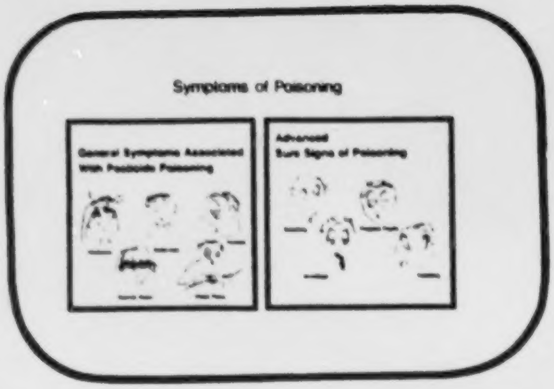


Dermal exposure is skin contamination. It can occur any time a pesticide is mixed, applied, or handled, and it is often undetected. Its seriousness depends upon (1) the dermal toxicity of the material; (2) the rate of absorption through the skin; (3) the size of the skin area contaminated; and (4) the length of time the material is in contact with the skin. Like oral exposure, dermal exposure can be expressed as an LD_{50} value.

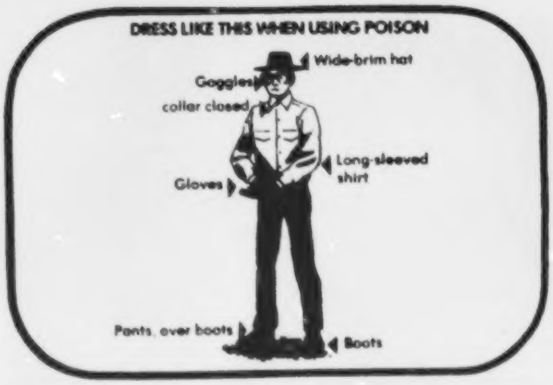
Rates of absorption through the skin are different for different parts of the body. Using absorption through the forearm (1.0) as the standard, absorption is over 11 times faster in the lower groin area. Absorption through the skin in the scrotal area is rapid enough to equal the effect of injecting the pesticide directly into the bloodstream. At this rate, the absorption of pesticide through the skin into the bloodstream is more dangerous than swallowing it.



Inhalation exposure results from breathing in pesticide vapors, dust, or spray particles. Inhalation exposure can occur from the applicator: smoking; breathing smoke from burning containers; breathing fumes from pesticides, while applying them without protective equipment; and inhaling fumes immediately after applying a pesticide.

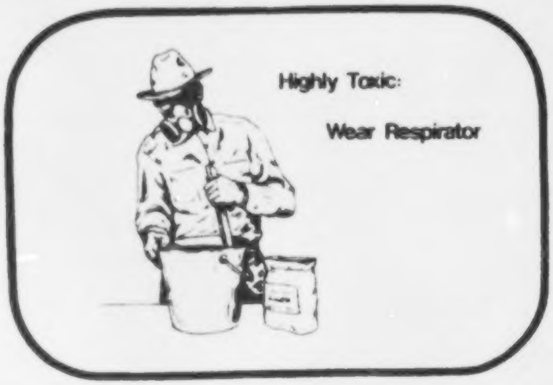

Symptoms of Poisoning
General Symptoms Associated With Pesticide Poisoning
Advanced Sure Signs of Poisoning

All people who use pesticides should be familiar with the symptoms of poisoning. If any of the symptoms listed occur, consult a qualified physician and tell him or her what pesticide you were using. In fact, it is a good idea to bring the container or label with you, so the doctor can read the prescribed treatment listed for the specific chemical contained in the pesticide.

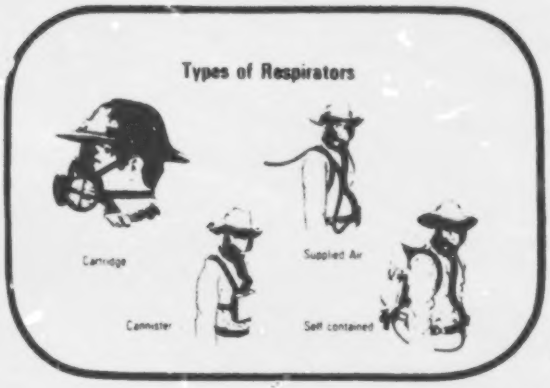

DRESS LIKE THIS WHEN USING POISON
Wide-brim hat
Goggles
collar closed
Long-sleeved shirt
Gloves
Pants over boots
Boots

When using any pesticide, wear at least a wide-brimmed, waterproof hat (or plastic "hard hat"), a long-sleeved shirt and long-legged trousers, or a coverall garment, and boots. When handling pesticide concentrates during mixing and loading, or when using highly or moderately toxic materials, you should also wear unlined rubber or neoprene gloves and boots, and goggles. Trousers and sleeves should be worn outside of boots and gloves to prevent pesticides from getting inside. If you will be working in a mist, or your clothes might become wet, wear a waterproof suit.

Clothing worn during pesticide handling should never be done with the family wash, but should be washed everyday after exposure to the pesticide. Clothes contaminated with highly toxic chemicals should be discarded and burned or buried.


Highly Toxic:
Wear Respirator

When mixing concentrated, highly toxic pesticides, wear all protective clothing and equipment, including a respirator.

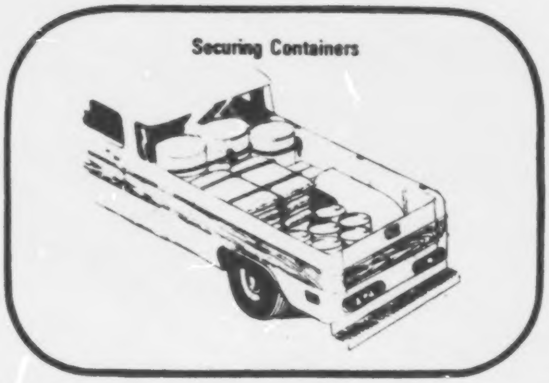


Types of Respirators

There are a number of types of respirators which you could use:

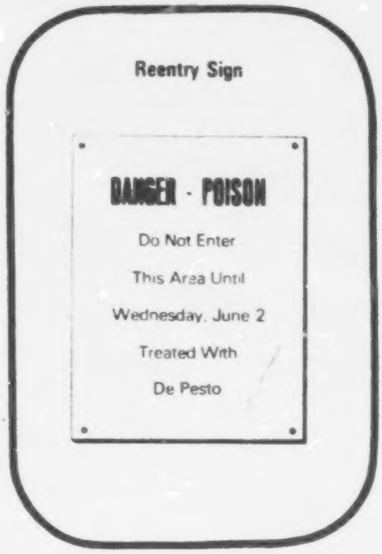
- the cartridge respirator, when you will be exposed to concentrated chemicals for short periods of time or exposed to low concentration of toxic chemicals for a long time;
- The gas mask or cannister respirator, when exposed to toxic fumes in heavy concentrations for long periods of time;
- air-supplied respirators and self-contained respirators, when oxygen supply in the air is low or when exposed to high concentrations of highly toxic pesticides in enclosed areas.

You should make sure the respirator you are using fits properly on your face, that the filter is checked at least every 8 hours of use, that the face piece is cleaned with detergent and warm water, and that you are using a respirator which has been approved by the National Institute for Occupational Safety & Health. A stamp will appear on the respirator with the letters N-I-O-S-H.



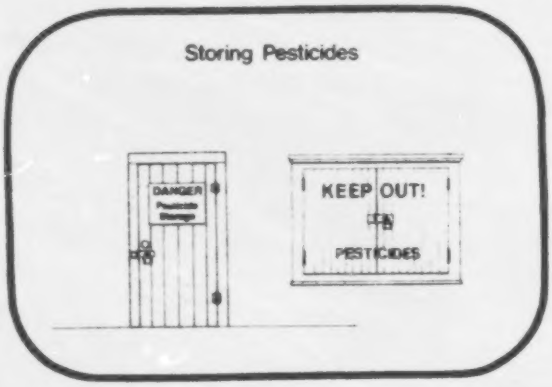
Securing Containers

When transporting pesticides, never carry them inside a car or truck cab. Secure the containers to keep them from shifting, rolling, or bouncing. Never transport livestock feed, seeds, or groceries in the same load with pesticides. Children should never be allowed to ride on or near the pesticides. Carelessness in moving pesticides can result in broken containers, spills, contamination, and injury to people and animals.

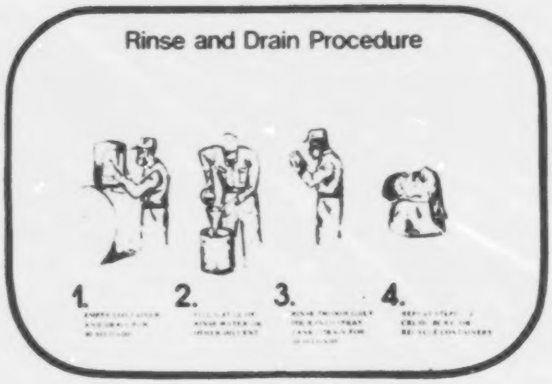


Reentry Sign

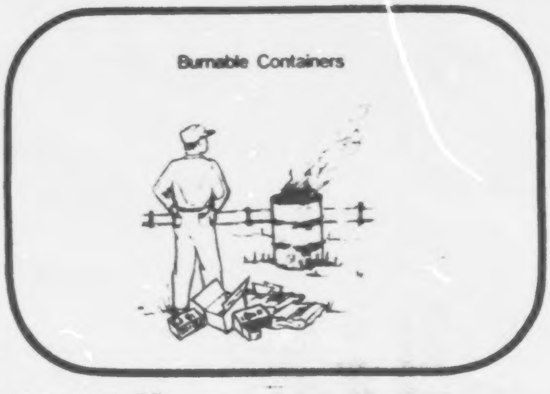
After pesticide application, wait at least until the deposit has dried or the dust has settled before reentering the field, even with the least hazardous pesticides. Check the label for reentry time. Do not allow workers, children, or other persons to reenter the area until the reentry time has passed.



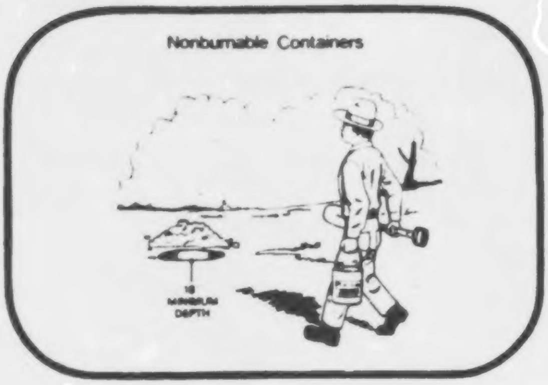
In your work, do not get in such a hurry that you forget to store the chemicals. Pesticides should be stored in their original containers and placed in a safe, dry, well-ventilated, and locked place. If the original label has been removed, label it, seal it, and put it where children and animals cannot reach it. Empty containers should also be put in a locked place or disposed of in the directed manner.



Containers which appear to be empty still contain small amounts of pesticides after they have been rinsed. Use this rinse-drain procedure to prepare containers for final disposal: 1) Empty containers into the spray tank and drain in a vertical postion for 30 seconds. 2) Fill the container one-fifth to one-fourth full with rinse water or other diluent. 3) Rinse thoroughly and pour into the spray tank and drain in a vertical position for 30 seconds. 4) Repeat steps one through three until the container has been rinsed three times. The rinsed container should then be punctured or crushed for recycling or burying.



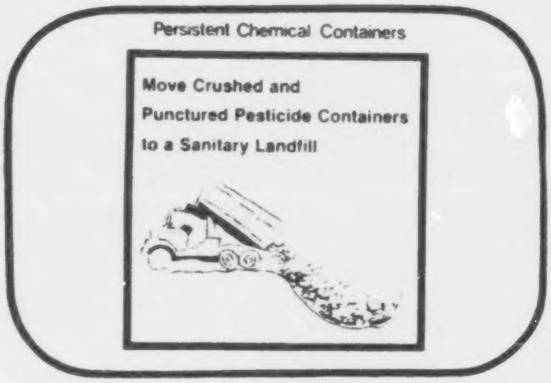
There are three groups or types of pesticide containers. Containers which burn, and do not contain mercury, lead, cadmium, or arsenic pesticides, should either be burned in special pesticide incinerators or in small numbers in the open (in keeping with local regulations) or buried in a special landfill. You may wish to bury it yourself. Each should be buried singly at least 18 inches (46 cm) deep in open fields.



Nonburnable Containers

Containers which will NOT burn and will have held the same pesticide as those just mentioned, should be rinsed thoroughly.

After rinsing, they should either be returned in good condition to your supplier for reuse, delivered to a scrap metal dealer, or crushed and buried.



Persistent Chemical Containers

Move Crushed and
Punctured Pesticide Containers
to a Sanitary Landfill

Containers which held organic mercury, cadmium, lead, arsenic or inorganic pesticides, should be taken to a specially designated landfill, after they have been rinsed. Surplus pesticides must also be taken to a specified landfill, to avoid human hazard or contamination of water supplies.

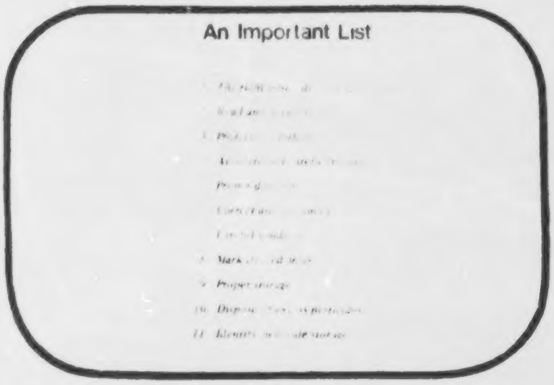
F.I.F.R.A.

1. Classification
2. Certification
3. Compliance

Many of the areas covered in this lesson are based on the 1947 Federal Insecticide, Fungicide, and Rodenticide Act, which was amended in 1972. The amended act (called "FIFRA" for short) states that:

1. All pesticides must be classified as either general or restricted.
2. An applicator must be certified as competent to use any of the pesticides classified for restricted use.
3. Anyone who does not obey the law is subject to fines and jail terms.

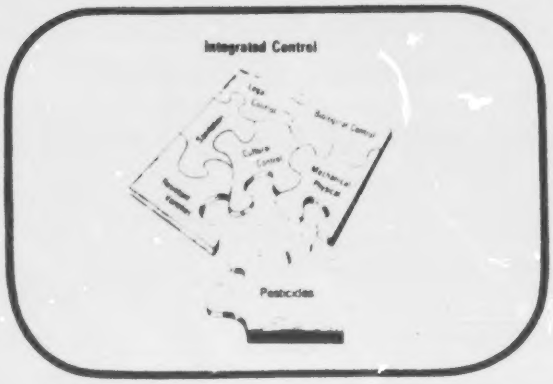
Pesticides can be used safely, if you are aware of their potential hazards. It is when they are handled, stored, or used carelessly that they become dangerous. Careful use can reduce the risk of accidental poisoning and environmental harm. Here is an important list of eleven basic things which you should remember when using pesticides:



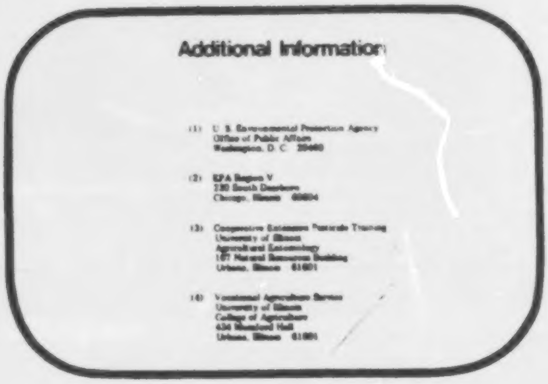
An Important List

9. Proper storage

1. Select the correct pesticide and application equipment for the particular pest problem.
2. Read and heed the label. Follow all directions and observe all safety precautions. Pay particular attention to specific warnings and first aid measures. Consult your dealer or an agricultural authority if you have any questions on usage of the product. Make sure everyone working with you also understands what to do.
3. Use the appropriate personal protective equipment to shield you from harmful contact with toxic materials.
4. Mix accurately and carefully. Keep children, pets, and nonworkers out of the area. Clean up spills. Return unused pesticides to safe storage promptly.
5. Thoroughly rinse and drain empty glass, metal, or plastic pesticide containers. Keep empties in a safe place until they can be discarded. Never leave them lying around.
6. Set up application equipment for proper dosage and apply carefully for good coverage, with minimum drift. Avoid pesticide application on windy days.
7. Clean up your application and protective equipment when finished. Do not smoke or eat until you have changed clothing and washed up.
8. Post or identify treated areas, to warn people to stay out.
9. Store pesticides by themselves in original labeled containers in a cabinet, room, or building that can be locked.
10. Dispose of excess pesticides as suggested by the label.
11. Identify pesticide storage with a sign at the building entrance and another on the door to the actual room or cabinet where they are kept. This will inform visitors and firefighters where pesticides are stored, so they can take needed precautions.



As you work with pesticides, seek to learn and understand more about them. Find out how they can serve you safely. The best type of pest-control plan is one which uses integrated control, putting all control methods together into a planned program to achieve pest control, while at the same time protecting people and the environment.



Additional Information

(1) U.S. Environmental Protection Agency
Office of Public Affairs
Washington, D.C. 20460

(2) EPA Region V
230 South Dearborn
Chicago, Illinois 60604

(3) Cooperative Extension Pesticide Training
University of Illinois
Agricultural Entomology
167 Natural Resources Building
Urbana, Illinois 61801

(4) Vocational Agriculture Service
University of Illinois
College of Agriculture
434 Mumford Hall
Urbana, Illinois 61801

More information about pesticides can be obtained from the U.S. Environmental Protection Agency, Office of Public Affairs, Washington, D.C. 20460; or the regional EPA office, EPA Region 5, 230 South Dearborn, Chicago, Illinois 60604; or Cooperative Extension Pesticide Training, University of Illinois, Agricultural Entomology, 167 Natural Resources Building, Urbana, Illinois 61801; or Vocational Agriculture Service, University of Illinois, 434 Mumford Hall, Urbana, Illinois 61801.

SAMPLE TEST QUESTIONS

AND TEACHERS KEY

Identifying and Controlling Pests of Horticultural Crops

1. What are the 3 most common pests?

   a. Diseases

   b. Insects

   c. Physiological Problems

2. Name 4 problems that commonly occur as a result of the culture of the plant.

   a. Nutrient Deficiencies   climate

   b. Nutrient Toxicities   other (see information sheet)

   c. Soil Problems

   d. Chemical

3. What problems occur in the greenhouse that may cause the poor germination of seeds?

   a. Improper temperature   High Salts

   b. Improper Moisture   Chemicals

   c. Lack of light

   d. Damping Off

4. Identify 5 relatives of insects that are thought of as insects.

   a. Mite

   b. Tick

   c. Spider

   d. Millipede

   e. Centipede

5. What is a pathogen?

   A plant disease is any condition which causes abnormal plant development.

6. Name 4 common plant diseases.

   a. Fungi

   b. Bacteria

   c. Viruses

   d. Nematodes

7. Three factors are necessary before an infectious disease can occur; they are:

   a. Susceptible Host Plant

   b. Favorable Environment

   c. Causal Organism

8. Describe the difference between complete and incomplete metamorphosis.

   a. Complete: Egg Larva Pupa Adult

   b. Incomplete: Egg Nymph Adult

9. Insects are classified by their mouth parts and the damage those mouth parts inflict on plants. Name four types of insect mouth parts.

   a. Chewing Lapping

   b. Sucking Siphoning

   c. Sponging

   d. Piercing Sucking

10. Identify 6 injuries which occur to plants as a result of machine damage.

   a. Lawn mower damage taking the bark off trees

   b. Lawn mower damage due to poorly sharpened blades

   c. Compaction damage due to heavy traffic of construction

   d. Leaking oil from a vehicle on turf

   e. Scalping turf from mowing to close

   f. Disease damage due to poorly pruned plant material

11. Identify four animals and describe the damage they can do to plant materials.

    a.

    b.

    c.

    d.

12. What is the simplest and most effective method of disease control?

    a. Plant Disease Resistant Varieties

13. Why is it important to keep a record of chemicals used on pests?

    a. Safety

14. Identify the information to be kept in a chemical record.

    a. Product and trade name used

    b. Percent of active ingredient

    c. Dilution used

    d. Dates of application

15. Identify the 6 major air pollutants which are pests to plants.

    a. Sulfur Dioxide

    b. Florides

    c. PAN

    d. Ozone

    e. Ethylene

    f. Chlorides

16. What conditions determine the amount of damage done by air pollutants?

    a. Kind

    b. Concentration

    c. Distance from the source

    d. Length of exposure

    e. Meteorological Conditions

17. How do pollutants enter the leaf?

a. through the stomata

18. Identify 5 types of pesticides.

a. Insecticides
b. Fungicides
c. Herbicides
d. Rodenticides
e. Nematicides

Defoliants and Dessicants
Bactericides
Miticidedes
Repellants and Attractants

19. What do these abbreviations stand for on a pesticides label.

S	1. Solutions
EC or E	2. Emulsifiable Concentrates
WP or W	3. Wettable Powders
SP	4. Soluble Powders
L or F	5. Flowables
G	6. Granules

20. What is Oral and Dermal Toxicity?

21. Describes the parts of the pesticide label.

22. Identify the steps to follow in safely using a pesticide.

TRUE (+) - FALSE (0)

0	1.	A mite is an insect.
+	2.	A termite is an insect.
+	3.	An insecticide is a pesticide.
0	4.	A herbicide is not a pesticide.
+	5.	There is a species of aphids for almost every species of plants.
0	6.	Scale insects feed on vegetation by chewing.
+	7.	Some insects have piercing-sucking mouth parts.
+	8.	A boxelder bug is an example of an insect that has incomplete metamorphosis.
+	9.	The lady beetle is a beneficial insect.
+	10.	Chemicals are the number one weapon for immediate control of insect pests.

MULTIPLE CHOICE (Mark appropriate choce of A, B, C, or D)

D	1.	The stages of complete metamorphosis or development are: A. Egg, nymph, adult B. Egg, nymph, pupa, adult C. Egg, larva, adult D. Egg, larva, pupa, adult
D	2.	Different kinds of insect mouthparts are: A. Siphoning and lapping B. Chewing and sponging C. Piercing-sucking and sucking D. All of the above
A	3.	Systemic poisons kill insects by: A. The insects feeding on the chemical from the sap of the plant which in turn acts as a stomach poison. B. Contact C. Attacking the nerve centers D. All of the above

B 4. The following is an insect:

A. Tick
B. Chinch bug
C. Mite
D. All of the above

C 5. Approximate number of insect species that have been identified:

A. More than 10,000
B. More than 300,000
C. More than 1,000,000

A 6. An example of a beneficial insect is the:

A. Praying mantis
B. Thrip
C. May beetle
D. Carpenter ant

D 7. Characteristic of nymphs:

A. Hatched from eggs
B. Go through a series of molts
C. Look like the adult insect
D. All of the above

C 8. Insect reproduction without fertilization is known as:

A. Entomology
B. Metamorphosis
C. Parthenogenesis
D. Nematoditis

D 9. Destructive insects may be affected by:

A. Parasites
B. Predators
C. Pathogens
D. All of the above

D 10. A cultural control of insect pests:

A. Spray tree with systemic or contact poison
B. Use adequate fertilizers
C. Select vigorous healthy plants
D. Both B and C

MATCHING (Select the matching answer from the right column that most accurately fits the item or description in the left column. Make selections according to information presented in VAS Unit 5021.)

I 1. Assassin bug
H 2. Metamorphosis
J 3. Parthogenesis
A 4. Stomach poisons
K 5. Contact poisons
F 6. Larva
B 7. Acaracide
L 8. Gall
D 9. Attractant
M 10. Chemical sterilant

A. Used especially to control insects with chewing mouthparts
B. A miticide
C. Kills itself
D. Insect lure
E.. Resembles the nymph
F. Worm stage (caterpillar, maggot, or grub)
G. Beginning the control with a "partho" insect powder
H. Change in shape and appearance from egg to adult
I. Beneficial insect
J. Reproduction without fertilization of the egg
K. Used on insects with any kinds of mouthparts
L. Abnormal growth appearing on leaf or twig
M. Affects insects' capacity to reproduce

COMPLETION (Write the appropriate word or words to complete the statements.)

1. Most borers that attack trees or shrubs are the larvae of beetles or moths.

2. Mites are especially destructive to evergreens.

3. Aphids have sucking mouthparts.

4. Scale insects are small and inconspicuous, and are likely to be overlooked until the branches of infested trees or shrubs are encrusted with them.

5. Heavy infestations of aphids usually produce a noticeable amount of honeydew, on which sooty mold may grow.

6. Avoid repeated or prolonged contact of insecticide with your skin.

7. An antidote is a remedy used to counteract the effects of a poison.

8. A parasitic insect is one that lives in or on the body of another insect.

9. An insect may be defined as a small invertebrate animal with three body regions and six jointed legs.

10. To detect the presence of insects before they cause serious damage to valuable trees and shrubs, you should examine the plants carefully at least once a week during the growing season.

ESSAY QUESTIONS

1. Relate the safety precautions that must be taken with insecticides so they will not be injurious to man and animals.

(See page 8) VAS Unit 5021

2. How do you tell a termite from an ant?

(See page 3) VAS Unit 5021

UNIT 1: Urban Animals

PROBLEM AREAS:

1. Care and feeding of the family dog
2. Care and feeding of the family cat
3. Care and feeding of the family horse

URBAN ANIMALS

UNIT I: URBAN ANIMALS

PROBLEM AREA: CARE AND FEEDING OF THE FAMILY DOG

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshman or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the winter months when working outdoors is not practical.

The estimated instructional time for this problem area is 5 to 10 days. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instruction can be 5 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

It is suggested that prior to teaching the feeding portion of this problem area that all students will have received instruction in Basic Animal Nutrition as presented in VAS Unit #1026a and 1013a.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this packet are for reference or modification as instructors adapt this problem area to their local situation.

CREDIT SOURCE:

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The teacher's guide, sample test questions, and student worksheets, were developed by Jim Ethridge. Test questions were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers. The information sheet author is unknown.

TEACHER'S GUIDE

I. Unit: Urban animals

II. Problem area: Care and feeding of the family dog

III. At the conclusion of this problem area, students will be able to:

1. Identify problems found in the caring of dogs.
2. Determine the needs of a dog in a household.
3. Properly care for a dog (while young & pregnant too).
4. Properly feed a dog.
5. Seek out additional information on his or her dog.
6. Identify the diversity of the dog industry.
7. Name six classes of nutrients and explain their function.
8. Explain the characteristics of a good ration.
9. Describe the major characteristics to consider when selecting a dog.
10. Identify the major parts of a dog.
11. Discuss the common uses of a dog and the characteristics important for each use.
12. Identify internal and external pests of dogs.

IV. Suggested interest approaches:

1. Attend a dog show.
2. Visit a veterinary hospital.
3. Visit a kennel and/or dog pound.
4. Bring feed sample to class and have students try to identify the contents.
5. Have available feed tags on food labels and have students identify the nutrient content of each foodstuff.
6. Ask students to explain what they feed their dog and guidelines used in considering food selection.

7. Show films from breed associations depicting ideal breed characteristics of dogs.

8. Use discussion groups to have the class develop a list of characteristics to consider when selecting a dog.

V. Anticipated problems and concerns of students:

1. What do we need to know about feeding and caring for dogs in order to accomplish our objectives?

2. What is the history of the dog?

3. What are the major breeds of dogs used as household pets?

4. What are the six breed groupings of dogs?

5. How is a dog selected for the household?

6. How can a dog be housebroken?

7. How should a dog be fed?

8. What accessories are needed for dogs?

9. To mate or not to mate, is this an important question?

10. What needs to be done when the bitch is pregnant, and when the puppies are born?

11. How are puppies weaned?

12. What are some tips on grooming dogs?

13. What are some tips for training dogs?

14. What are the major diseases and parasites of dogs?

15. What are the symptoms of a sick dog?

16. What are the parts of the digestive system?

17. What are the parts of the ruminant stomach?

18. What is the function of each part of the digestive system?

19. What is a ration? What is a balanced ration?

20. What are nutrients?

21. What is the function of each nutrient?

22. What are the characteristics of a good ration?

23. What is a good ration vs. a balanced ration?

24. What are the differences among concentrates, a roughage and other feed materials?

25. What are "rules of thumb" used in feeding dogs?

26. Why do dogs need water? What are water needs for dogs? What problems are involved in over-watering dogs?

27. When should a dog be fed? How much should dogs be fed?

28. How does one determine nutritional requirements of dogs that are young, adult, pregnant or orphan animals?

29. What are the main uses of dogs?

30. What are the differences among selecting a dog for breeding, working or for a pet?

31. What terms does one need to know when identifying parts of a dog?

32. What parasites are found in or on dogs?

VI. Suggested learning activities and experiences:

1. Distribute VAS Unit 1026a, Digestion in Animals, and have students tentatively answer the identified problems and concerns.

2. Identify and define the important terms related to animal feeding.

3. Identify and discuss the purposes and characteristics of good rations.

4. Use the Worksheet "Digestion in Animals." Have students complete and turn in for evaluation. reference (VAS #1026a)

5. Use the Worksheet "General Facts on Animal Feeding." Have students complete and turn in for evaluation. (reference VAS 1013a.)

6. Identify nutrition requirements for different stages of growth in dogs.

7. Distribute pictures of dogs of different quality and have students select the ones they would purchase. Have the students give reasons for their choice and write them down for discussion.

8. Distribute pictures or show slides of dogs for judging. Discuss the factors one should consider in each circumstance.

9. Distribute a worksheet and have students identify the parts of the dog. Discuss the importance of knowing the parts of the dog when selecting animals for sale, pets, breeding or for show.

10. Show slides or transparencies of "ideal dogs" and discuss the important characteristics of each of the different views.

11. Using slides, pictures or live animals, have students judge and place rings of dogs for pets, and breeding - using appropriate judging cards and judging booklets.

12. Have the students identify problems and concerns on selecting and purchasing a dog.

13. Take a field trip or invite a purebred breeder to class to discuss the characteristics they consider when purchasing their animals.

VII. Application procedures:

1. The main purpose of this problem area is to introduce the students to the correct feeding procedures for animal groups - dogs, cats, birds and zoo animals.

2. This problem area should provide students with the basic information on digestion and the classes and functions of feeds.

3. The students can use this information for identifying animals to consider for an SOE project.

4. This problem area can prepare students for participation in judging contests and added interest in shows.

VIII. Evaluation:

1. Collect and grade worksheets and list of information found on a feed tag.

2. Administer and evaluate an exam on digestion, nutrients and feeding and selecting dogs.

3. Laboratory examination on identification of feed components.

4. Calculate price per pound of a prepared dog food.

IX. References and aids:

1. Information Sheet on Dogs.

2. Information sheet on Save Money with Pet Food.

3. Student Worksheet on

   a) General Facts on Dog Feeding

   b) Digestion in Dogs

   c) Profile of a Dog

   d) Profile of a Dog-Teacher's key

   e) Breeds of Dogs

4. Sample Test Questions and Teacher's Key

5. Available form your local County Cooperative Extension Service

   a) 4-H Training Your Dog for Family Living 23p

   b) 4-H Dog Obedience Training Lessons 16p

   c) 4-H Grooming and Handling Dogs 15p

   d) 4-H Dog Obedience for Beginners 19p

6. Vocational Agricultural Service Units

   a) #1013a "Digestion in Animals"

   b) #1026a "General Facts on Livestock Feeding"

7. Vocational Agriculture Service Slide Set

   a) # "Breeds of Dogs"

INFORMATION SHEET ON DOGS

WHAT IS THE HISTORY OF THE DOG?

The dog has the same ancestor as the cat. The long-extinct Miacis, through evolution, evolved into the "canidae" or canine. The earliest mention of the dog, as we know it today, was in the Old Testament. In the course of the reference in the Bible to the dog, the most definite were the ones mentioned with the Egyptians and Assyrians. The dogs in Egypt were used as pets and for hunting.

After importation to the United States, the dog went wherever man went and served as a watchdog, herd dog, pet, and hunting dog.

WHAT ARE THE MAJOR BREEDS OF DOGS USED AS HOUSEHOLD PETS?

The American Kennel Club is the major source of information on the breeds of dogs in the United States. They publish a list of the most popular breeds of dogs in the United States according to their popularity. A description of the top five breeds has been added.

Poodles - National Dog of France, actually descended from German Pudel-retriever and circus dog. Average weight 55 pounds, height 23 inches. Colors: solid black, white, silver, gray, apricot, brown.

German Shepherd Dogs - Heroism in World War I began popularity in United States where renowned as guide and army dog. Average weight 75 pounds, height 25 inches. Coat dense. Color: black-and-tan or gray, various rich colors.

Beagles - From England and long popular in America; hunter's favorite for rabbit and have two sizes: under 13 inches, weight 18 pounds; over 13 inches - 15 inches, 30 pounds. Short coat in white, black, tan; any hound color.

Dachshunds - German name meaning "badger dog" for ancestors that fought the vicious badger underground. Highly popular as pet. Average weight 20 pounds, height 9 inches. Standard and miniature (under 10 pounds).

Irish Setter - Bred in the Emerald Isle in the 18th century, brought to America in early 1870's. Average weight 60 pounds, height 25 inches. Coat: long, straight with fringes. Color: deep rich mahogany, chestnut, red.

Sporting Dogs - There are three basic types of sporting dogs, divided according to their use. These are the pointing breeds, the spaniel or flushing breeds, and those used primarily for retrieving, often in the water. There are exceptions. For instance, the Brittany Spaniel is the world's only pointing spaniel. Irish and American Water Spaniels are used chiefly as retrievers. Examples: Pointer, English Setter, Cocker Spaniel, and Laborador Retriever.

Hound Breeds - The Hound Group is made up of two very different types of hound - the scent follower and the sight hunter or "sight hound." Examples: Scent - Beagle and Basset, Sight - Dachshund and Greyhound.

Working Dogs - As the term suggests, the dogs which make up this group were developed to labor for a living. They might pull milk cars, do police duty, carry messages, or guard and herd sheep, cattle or other animals. Examples: Boxer, German Shepherd, Collie, and Doberman Pinscher.

Terrier Dogs - In this group are generally those which go into the earth, "terra," after game. Their job was to go into holes that were too small for the larger hounds and there do battle with and bring out the quarry. For centuries farmers have used them to keep down rats and vermin. Big-game hunters have relied on the larger terrier breeds to go in and finish off the quarry in close fighting. Their courage, ability and style have always won the admiration of dog lovers everywhere. Examples: Wire Fox Terrier, Schnauzer, Scottish Terrier, and Airedale.

Toy Dogs - The toy breeds can be described as those dogs weighing between 1½ to 18 pounds. Some Chihuahuas are as small as the former, and the latter is the top weight for the Pug. Because of their small size, the toy breeds are very popular as house pets and companions. They are very alert and make excellent watchdogs. Examples: Chihuahua, Pug, Pomeranian, and Pekingese.

Non-Sporting Dogs - This group is made up of a miscellaneous collection of breeds with a wide variety of characteristics, sizes and backgrounds. They may now be generally classified as companion dogs. Examples: Boston Terrier, Bulldog, Dalmatian, and Poodle.

The Non-Sporting Breeds

Chow Chow
Dalmatian
Keeshond
Boston Terrier
Tibetan Terrier
Schipperke
Standard Poodle
Miniature Poodle
Bichon Frise
Lhasa Apso
Bulldog
French Bulldog

The Terrier Breeds

Airedale
Bull
Kerry Blue
Irish

The Toy Breeds

Shih Tzu
Papillon
Japanese Spaniel
English Toy Spaniel
Miniature Pinscher
Pekingese
Pomeranian
Pug
Toy Poodle
Yorkshire Terrier
Silky Terrier
Toy Manchester Terrier
Brussels Griffon
Italian Greyhound
Affenpinscher
Maltese
Chihuahua (long coat)
Chihuahua (smooth coat)

Welsh
Scottish
Australian
Manchester
Bedlington
Lakeland
Border
Cairn
Norwich
Sky
American Staffordshire
Soft-coated Wheaton
Dandie Dinmont
West Highland White
Fox (Wire)
Fox (Smooth)
Miniature Schnauzer
Sealyham

The Working Breeds

German Shephard
Belgian Sheepdog
Old English Sheepdog
Shetland Sheepdog
Belgian Tervuren
Bernese Mountain Dog
Komondor
Briard
Collie (Rough)
Collie (Smooth)
Mastiff
Bullmastiff
Great Dane
St. Bernard
Newfoundland
Great Pyenees
Kuvasz
Rottweiler
Doberman Pinscher
Bouvier des Flanders
Akita
Boxer
Giant Schnauzer
Puli
Standard Schnauzer
Pembroke Welsh Corgi
Cardigan Welsh Corgi
Siberian Husky
Samoyed
Alaskan Malamute

The Hound Breeds

Irish Wolfhound
Borzoi
Scottish Deerhound
Afghan Hound
Greyhound
Saluki
Rhodesian Ridgeback
Black and Tan Coonhound
Otterhound
Bloodhound
American Foxhound
English Foxhound
Whippet
Norwegian Elkhound
Harrier
Beagle
Basset Hound
Basenji
Longhaired Dachshund
Wirehaired Dachshund
Smooth Dachshund

The Sporting Breeds

Pointer
German Shorthaired Pointer
Wirehaired Pointing Griffon
German Wirehaired Pointer
Weimaraner
Vizsla
Irish Setter
Gordan Setter
English Setter
Labrador Retriever
Golden Retriever
Flat-coated Retriever
Curly-coated Retriever
Chesapeake Bay Retriever
Irish Water Spaniel
Sussex Spaniel
English Springer Spaniel
Field Spaniel
American Water Spaniel
Welsh Springer Spaniel
Clumber Spaniel
Brittany Spaniel
English Cocker Spaniel
Cocker Spaniel

HOW IS A DOG SELECTED FOR THE HOUSEHOLD?

The idea of selection is to choose a dog that will fit the owner's lifestyle. Some factors to consider when selecting a dog are: (1) size of living quarters; (2) number and age of children; (3) the way the people live; and (4) the owners temperament. For example, a person that lives in a city apartment should not select a Great Dane because there would not be a chance to exercise the dog properly.

If the owner selects a female, is he or she willing to keep any puppies she might deliver or keep her safe while she is in season? Consideration must also be given to the economic aspect, large dogs can consume ten pounds of feed a day. The most important point in selection is to buy the dog from an established breeder or pet dealer to be sure the dog is healthy.

HOW CAN A DOG BE HOUSEBROKEN?

Housebreaking a dog is an area of controversy between pet book authors. The general concensus seems to be to start training your dog when he is between four and six weeks old. Housebreaking a dog is an easy task, but the owner must first decide whether the dog is to be trained to urinate and defecate indoors or outdoors. A person who lives in a multi-floor apartment with a long way to get to the street or yard would, in most cases, paper train the dog indoors. Persons with easy access to the outdoors would probably choose the second method.

Paper or indoor training. This training method is simple and can be accomplished in a week. Dogs are naturally clean animals and generally will leave the bed to urinate and defecate. When the owner sees the dog leave his bed and sniff around or squat, the owner should pick up the dog and place him on some paper placed near the dog's bed. After the dog has relieved himself, praise him for using the paper. Be sure to take the dog to the paper each morning after waking, after each meal, after hard play, and just before bedtime; this will help the dog to understand when he is to go to the papers to relieve himself. If the dog should soil elsewhere in the home, clean it up quickly and disinfect the spot thoroughly. Do not punish the dog unless he has been caught in the act. If he is scolded after the fact, his short memory will not see the relationship between the mess and the scolding. Once the dogs scent is on the paper, he will return to the paper knowing it is the right spot.

Outdoor training. Outdoor training follows several of the same principles found in paper training. When the puppy is of age or an older dog needs training, the first step is to take the dog outside in the morning, evening, after meals, and after play to urinate and defecate. After the dog is outside, a spot should be found to act as a training spot to take the dog to each time he comes outdoors. A marker for the dog could be a rag that cleaned up one of his accidents in the home. The rag would have his scent and he will return to it again and again. Eventually (about two to three weeks), when the dog has learned that he is to go outside to urinate or defecate, the dog will go to the door and wait or scratch if he needs to go out.

Remember that only a stern word is needed to punish the dog, never use physical punishment because it will cause the dog to be afraid of the owner whenever he approaches the animal.

HOW SHOULD A DOG BE FED?

Before feeding any animal, a person must consider what its requirements are for good nutrition. The nutritional requirements for a dog as stated by the National Research Council are:

	National Research Council Recommendation*
Nutrient	Percent
Dry Matter	28
Protein	6.7
Carbohydrate (maximum)	20
Fat	1.5
Fiber	NR
Ash	NR
Calcium	0.3
Phosphorus	0.24
Potassium	0.24
Sodium Chloride	0.43
Magnesium	0.014

Nutrient	Mg. Per Pound of Feed
Iron	7
Copper	1
Cobalt	0.3
Manganese	0.6
Zinc	0.6
Iodine	0.2
Vitamin A	600 IU
Vitamin D	40 IU
Vitamin E (Alpha Tocopherol)	6
Vitamin B-12	0.003
Folic Acid	0.02
Thiamine	0.1
Riboflavin	0.24
Pyridoxine (B-6)	0.12
Pantotenic Acid	0.3
Niacin	1.3
Choline	150

*Based on NRC Requirements of Dogs--Revised 1962--Table 1--" Nutrient Requirements of Dogs"

Another consideration is the stage of growth of the dog. Puppies need a feed that has a higher percentage of certain nutrients than full grown dogs (refer to the Puppy Chow commercial on television). Commercial feeds are readily available that fill the nutritional requirements of these animals. In addition, the information on requirements and foodstuffs that are used to fill these requirements are found on the can or package of every dog food product.

Dividing the dog group into two separate groups is the best way to present the feeding schedules and the amount of feed for each animal, as related to the age of the dog.

Puppies have special feeding requirements. They are:

For puppies three to four weeks old. In addition to feeding by nursing, the puppies should be offered a gruel of one part water, milk or broth and one part puppy food, twice a day. Regulate the amounts at about 1 ounce per pound of body weight, because a puppy's eyes are often bigger than its stomach.

For puppies five to seven weeks old. At this point the mother should begin weaning the pups. The amount of puppy food in the gruel should increase to two parts feed to one part water. The number of meals per day should also increase because the puppies are receiving less nourishment from their mother. The daily amount of feed will vary according to body weight. The rule of thumb is to feed 1 ounce per pound of body weight divided into two to three feedings a day.

For puppies seven weeks to three months of age and completely weaned. The amount of feed should be increased proportionately with the puppy's body weight and the number of feedings should also increase to three to four a day.

For puppies three to six months old. The number of feedings should decrease to three a day during this fast growing period. Do not be surprised if the pups double their weight during this period. Feed them so they have all they can eat.

For puppies six to twelve months old. The feedings per day can be dropped to two, because the puppy's stomach has a greater capacity and his growth rate is leveling out.

When feeding the adult dog, there are several areas to consider:

Do you want to feed dry or canned dog food? Dry dog food contains about 23 percent protein, seven percent fat, 24 percent carbohydrates, and about 10 percent water. This type of feed wll deliver from 1,650 to 2,000 kilocalories per pound. It is balanced for all nutrients, and can be served dry, moist, or mixed with other foods.

Canned dog food contains about 10 percent protein, four percent fat, eight percent carbohydrates, and up to 75 percent water. This type will deliver from 650 to 700 calories per pound.

How much, and how often should the adult dog be fed? A good rule in feeding adult dogs is to feed one-half ounce of dry dog food per pound of dog per day. Adjustments must be made when serving canned dog food because it is about 75 percent water. So when feeding canned dog food, the amount should increase to one or one and one-half ounces per pound of dog per day.

An adult dog only needs to be fed once a day to satisfy his hunger. The best time to feed him is just before the owner's dinner time so the dog will not beg for food while the owner is eating.

If the owner decides to give a bone to his dog, should he first consider the type of bone he plans to give to the dog? Most bones are small and splinter easily when chewed by a dog. Large bones like shanks or knuckles are the best, with chicken and fish bones the least desirable bones. The bone does little to add to the nutrition of the dog, it only helps to clean the tartar off his teeth.

When feeding the pregnant dog, the bitch requires a small increase in food consumption. What needs to be watched carefully is the nutrient quality of the ration. The owner should use a quality tested feed that fills the nutritional needs of the bitch. After she has given birth, the bitch needs additional food to produce milk for her pups. When her pups are four weeks old, she will need about double her pregnant ration to continue producing enough milk for the litter.

When the puppies are to be weaned after about six weeks of nursing, be sure the pups are eating solid food. Cut the ration of the female according to the following schedule to help her dry her teats:

1st day	no food
2nd day	one-fifth her normal ration
3rd day	two-fifths her normal ration
4th day	three-fifths her normal ration
5th day	four-fifths her normal ration
6th day	she should be back on her pre-pregnant feeding schedule

When feeding field or working dogs, a special emphasis needs to be put on the amount of energy used by the animals. These dogs burn a tremendous amount of energy, so extra calories need to be added to their diet. A possible solution would be to add meat to the diet along with the regular dog food. This would help to increase the appetite and increase caloric intake. The addition of fats, such as lard, bacon grease or corn oil, will also increase the amount of energy consumed, raising the caloric intake.

The dog owner should stick to commercial dog food because of the problems that can occur by feeding the animal improperly. For example, milk, when given to an adult dog, can cause diarrhea, and raw eggs contain an enzyme that destroys the vitamin biotin.

WHAT ACCESSORIES ARE NEEDED WITH DOGS?

This equipment may vary according to the economic standing of the owner, the basic needs of the dog include:

Food pan
Water pan
Stiff brush
Comb
Collar - an inexpensive leather one for the puppy and a slip chain for the adult
Leash or lead
A grooming kit - clippers, scissors, etc.

For the more extravagant:

Coat
Boots
Curlers

For the hunting or working dog:

Penned area
Dog house and run.

All dogs need to be licensed if the law requires it. This will help avoid legal problems resulting from damages to property and help find the dog if he gets lost.

TO MATE OR NOT TO MATE, IS THIS AN IMPORTANT QUESTION?

Unless the owner is willing to take the responsibility for a litter of puppies, their birth should be prevented by not mating the female. This can be done by either spaying the female (make her unable to get eggs to the uterus) or watching carefully for the signs of estrus and then isolating the female for three weeks. The owner will know when the female is coming into heat by these signs: she will become restless; lose her appetite; and her vulva will become swollen. She will have a slight discharge or bleeding for four to seven days. After the discharge stops, she will be receptive to males for about a week. At this point she has been in heat for about two weeks.

If she is mated before the owner can confine her, a series of hormone injections have been developed to terminate the pregnancy. A veterinarian should be consulted for more information.

The male can be made incapable of breeding by having him neutered or castrated. This is a simple operation and can be helpful in reducing the dog population in a community.

On the other hand, a person with purebred dogs will most likely want to produce a litter. To do this efficiently, the breeder would need to be up to date on the physiology of the dog.

The onset of heat needs to be detected by looking for the signs discussed earlier in this section.

After the first signs have passed, the female enters a period when she will accept a male.

Do not breed the female on the first day of acceptance because ovulation does not occur until later in this time period.

As ovulation occurs, the vagina becomes dilated and softer, and the vulva becomes soft and flabby. This best indicates when to breed the bitch successfully.

Another detection method for ovulation is testing for glucose secretions. When a section of Lilly's Testape analyzer is inserted in the bitch's vulva three times a day, starting six or seven days after she comes into season, the Testape will gradually turn green, indicating that breeding condition has been reached.

According to authorities, the best breeding time is from 2 days before ovulation to 2½ days after ovulation.

When the female is ready to breed, place her in with a stud to see if he is interested in her. If he is, remove the female and perform a digital examination.

Clip the hair from around the vulva region.

Take a large piece of cotton and drain the anal glands, by pressing firmly both sides of the rectum at the same instant.

Then clean hands thoroughly and check the vagina carefully for any fibers or webs that might prevent the insertion of the penis (a veterinarian can show how this can be done).

Rupture any fibers or webs found. If this is not done, the male may hit them, withdraw, and refuse to mount again.

Set the bitch up for mounting by the stud by having an assistant hold her steady while the owner brings up the stud. Kneel on the left side, facing the rear of the bitch.

Lift the male up to mounting position, he may need a platform under his feet for support. With the left hand under the bitch, roll the folds of the vulva open. With the right hand, place the male's penis in correct position for proper entrance. As he moves into the vagina, place the right hand squarely on his stern, below the tail and push him on for complete penetration. By feeling at the same time, with the left hand, it can be determined if the locking glands are inserted.

With a good contact, and after the male stops a pumping to-treading action, hold him solid to the bitch for a couple of minutes, with the right hand on the stern. When the throb of the stud's anus at regular intervals is seen or felt, and not before, turn him slowly so that he faces in opposite direction to the bitch. The services is thus completed by a proper "tie."

Two services at 24 to 48 hour intervals, completed as positive ties, result in a higher rate of conceptions.

WHAT NEEDS TO BE DONE WHEN THE BITCH IS PREGNANT, AND WHEN THE PUPPIES ARE BORN?

The next step is to see that she is wormed by the second or third week of her pregnancy, because worms can cause her to abort or they will infest the puppies when born. During this nine week gestation period, she will develop a larger appetite. See that she is fed properly but not so she becomes overweight. Exercise the bitch frequently to help keep her weight down, because a dog that is too fat, can have delivery problems. The pregnant female must be treated carefully by the whole family or the excitement may cause complications, such as the abortion of the fetus. At the start of the fifth week, the female should be limited in her movements, such as jumping up or down on furniture because her belly at this time should be to the point where it could be bumped causing injury to the unborn puppies.

About the eighth week whelping preparations need to be started in the household. The veterinarian needs to be contacted to get instructions on handling the delivery or any problems that might occur. A box lined with the bitch's favorite blanket should be prepared and she should be put in it so the new surroundings will be familiar. About the 60th day the blanket should be replaced with newspaper which the bitch will shred and arrange herself as she approaches whelping time.

The dog is ready to whelp when she is nervously pacing, her abdomen is extended, she wimpers, pants and strains, and her vulva dialates slightly. A dog should be encouraged to her whelping box and nest there rather than somewhere else in the house.

When the female dog goes into labor, she will show signs of abdominal contraction, and she will consume a large amount of water. When the puppies begin to emerge, resist the temptation to help the bitch. Let the female do the work and do not interfere unless she is having extreme difficulty with delivery. The puppies will emerge enclosed in a membrane sac with an umbilical cord attached. The bitch will break the sac, bite off the cord, eat the membrane, and lick the puppy until he starts breathing. Sometimes the mother may reject the puppy so the breeder must act quickly to break the sac and the puppy breathing properly. Then take the puppy and rub it against the nose of the bitch to show her that it is her puppy. Each puppy will be followed by the passing of the placenta. The bitch will eat this also, but the breeder needs to count them to be sure a placenta is not retained in the uterus. If a placenta is retained, or the bitch is passing green mucus, call the veterinarian so he or she can solve the problem.

After the puppies have been delivered, check to see that they are getting milk from the mother. A sign of this is puppies with full, rounded bellies. Increase the mother's food supply gradually, and watch her carefully for any signs of illness or rejecting her puppies.

If the mother does not have enough milk for the puppies, the breeder will need to hand-feed them. A good mixture is one cup milk, one teaspoon corn syrup, and one egg yolk, fed with a small nippled bottle.

HOW ARE PUPPIES WEANED?

Referring back to section F, the puppies should be eating dog food by the age of six weeks. At this time, the puppies are separated from their mother and put on a full dog food diet. By this time the mother will be drying up and she should be removed from the whelping box and put on a special ration to dry her up completely. The puppies may cry, but they will soon quiet down and be eating only dog food in two or three days.

WHAT ARE SOME TIPS FOR GROOMING DOGS?

The first step toward good grooming is to acquire a grooming kit. The kit should contain:

Short- or long-bristled brush, depending on length of coat.
Comb with wide teeth for long-haired or wire-haired dog.
Stripping knife for wire-haired dogs; wool comb for long-haired dogs.
Scissors (barber type).
Nail clippers.

The dog should be brushed daily to remove foreign material, dead hair, and to stimulate his hair follicles to give a glossy coat.

When a dog gets dirty, he will need to be washed. The bath should be given in a draft-free warm room in warm water. A commercial dog shampoo is advisable but not necessary as long as the shampoo or soap is antibacterial. After washing, the dog needs to be thoroughly dryed before being let outside because he may catch a cold.

The next tip is to regularly clip the dog's nails. This will prevent the dog from scratching the furniture or another person. Unlike the cat, the dog does not need his nails to fight.

WHAT ARE SOME TIPS FOR TRAINING DOGS?

This section will be confined to teaching the dog some simple commands such as "heel," "sit," and "stay." When training a dog there are a few simple rules that need to be followed.

Reward and punishment are the basis for all training.

Work for brief periods only. Ten to fifteen minutes maximum.

Be consistent in your commands, body movements and voice inflections. Use the same words and motions.

Tailor your teaching technique to match the dog's disposition.

End every training session on a success. The puppy needs the owner's praise and approval.

Before starting, the only training tools the owner will need are a leash and a collar. A slip chain or choke chain collar is the best and a leash should be eight to ten feet long.

The first area to be covered is getting the dog to sit on command. With the dog standing on all fours, tell the dog to "Sit." At the same time pull back on the collar and push down on his rump. Hold him in this position repeating the command "Sit." Then praise by petting, giving a snack or using the word "Good." Repetition is the key to success.

The second area is to teach the dog to "heel." The purpose of this exercise is to teach the dog to walk quietly at the owner's left side. Hold the leash in the right hand and hold the leash close to the collar with the left hand. Now the owner is ready to start. Command the dog to "heel" and start walking forward slowly. If the dog tries to walk ahead or behind the owner a few jerks on the leash will bring the dog back to the heel position. When the dog has successfully "heeled" for ten feet or more, praise and reward him. Repeat the process often.

Teaching the command "stay," is a relatively simple obedience trick. Command the dog to "sit," and then put the hand drectly in front of the dog's face repeating the command "stay." If he gets up, force him back down into the sit position at the exact spot from which he got up. Slowly inch away from him repeating the command "stay." If he gets up, say "no" and set him back down.

The last command to be covered is "come." This is the most important and the most difficult lesson to teach the dog. To train him to "come," a light rope or cord 40 to 50 feet long should be attached to the dog's collar as an additional training tool. Allow the dog to stretch the rope out completely, then call his name or "come" and begin pulling him toward you while repeating his name. After he has reached the owner, the dog should be rewarded and praised. Again repetition is needed for successful results. The training should be practiced both outside and inside the house.

WHAT ARE THE MAJOR DISEASES AND PARASITES OF DOGS?

Shortly after a dog is adopted, or the puppies are two weeks past weaning, the dogs need to see a veterinarian to get a check-up and shots for the four most lethal canine diseases:

Distemper, a highly contagious virus disease that attacks the dog's tissues.

Hepatitis, a virus infection that primarily affects the liver tissue.

Leptospirosis acute infectious disease of dogs spread through contact of the mouth or nasal mucus membranes with the urine of either an infected dog or cat.

Rabies, a virus infection transmitted through the bite of infected animals.

The worms that cause trouble are the roundworms, hookworms, shipworms, and tapeworms. They can be diagnosed and treated by a veterinarian very easily.

External parasites are fleas, lice, ticks, mites. There are many powders on the market to control these parasites and should be used regularly for best results.

WHAT ARE SOME SYMPTOMS THAT INDICATE THE DOG IS SICK?

Loss of appetite.

The lower eyelid may hang down slightly, showing the red membrane.

The coat may have a harsh feel and a dead texture, both to the eye and the hand.

Mucus and traces of blood.

A potbelly, with the rest of the body skinny.

Lack of interest in anything.

Hiding in dark places.

Nasal discharges.

INFORMATION SHEET

SAVING MONEY WITH PET FOOD

Almost half (48%) of America's households own at least one dog and approximately one third of the households have one or more cats. These 48,846,000 dogs and 32,000,000 cats consume more than $3 billion retail value annually in food. This huge food intake offers opportunities for phenominal saving in food costs for many pet owners.

A newly born Labrador Retriever will, in his lifetime, estimated at 10 years, consume 6,400 pound of dry food (or three times this amount of canned food), drink 2,400 gallons of water, require an additional 36,500 gallons of water for cleaning, food preparation, and an estimated $2,000 for veterinary medical care, bedding, housing and accessories.

A cat living to twelve years of age may require 1,000 pounds of dry food (or 3,300 pounds of canned), consume 500 gallons of water and require an additional 3,000 gallons for food preparation and minimal cleaning of facilities.

The cost of feeding can be as low as $0.15 per day for a Labrador Retriever receiving an excellent dry food or up to $3.50 per day for enough of one of the more expensive canned foods to supply approximately the same nutrition.

Most pet foods sold in the U.S. market are nutritionally excellent. The wide range of prices depends on the amount of advertising, package size, and form of food.

It is logical that pet owners confronted with a wide array of foods are confused by pet food advertising. It can generally be assumed that most types of dog food are similar in nutritional content based on the moisture-free food commonly called dry matter. If units of dry matter from commercial dry foods, semi-moist, and canned foods are approximately equal, then the comparison of costs is relatively easy.

If a 6.5 ounce can of dog food retails for 33¢ including tax and contains 78 percent moisture then the cost is $(\$.33 \times \frac{16}{6.5} \times \frac{100}{22}) = \$3.69$ per pound of dry matter.

If a 36 ounce package of a popular semi-moist food retails for $1.30 including tax and contains 36 percent moisture, then the cost is $\$1.30 \times \frac{16}{36} \times \frac{100}{64}) = \$.90$ per pound of dry matter.

A 50 pound package of a leading brand of dog food retails for 11.20 plus 0.56 tax or $11.76 and contains approximately 10% moisture. Dry dog foods contain moisture, just like crackers left exposed to the atmosphere. The cost on a moisture-free basis is $\$11.76 \times \frac{1}{50} \times \frac{100}{90} = \$0.26$ per pound.

This is a difference of $3.43 per pound for moisture free nutrition or to rephrase, it is 14 times as expensive to feed a highly advertised canned food bought in 6.5 oz cans as it is to supply approximately equal nutrition with the leading dry food.

Canned foods offer the convenience of built-in moisture and most are more than 3/4 water. You can obtain water much more inexpensively from the sink faucet. Semi-moist foods contain only 40% moisture or less, but the expense of maintaining the freshness with anti-mold, antibiotics, and superior moisture impervious packaging creates added expense.

Most pet foods, whether canned, semi-moist, or dry, show label words "complete" and "balanced," which mean the pet food have been subjected to rigorous testing procedures for growth and reproduction or have been subjected to extensive calculations so the products conform to the National Research Council publications Nutritional Requirements of Dogs or Nutritional Requirements of Cats which helps assure those products are indeed adequate for growth and lactation.

Attractiveness of packaging, contents and advertising is for the anthropomorphism of the pet owner since dogs are colorblind and seldom influenced by packaging and color.

America's pets have diets that are completely balanced for them. Foods sold for America's children are not as well balanced and nutritious.

Careful shopping can save pet owners several hundred dollars over the pet's lifetime.

STUDENT WORKSHEET

GENERAL FACTS ON DOG FEEDING

1. Why do animals need nutrients?

2. List and give the functions of the six classes of nutrients.

   a.

   b.

   c.

   d.

   e.

   f.

3. What is the dfference between a "good ration" and a "balanced ration?"

4. Briefly state the "rules-of-thumb" to use when formulating rations for:

   Dogs

5. List some recommended practices in providing water for dogs.

6. Feed cost make up about ______ percent of the total cost of producing an animal.

STUDENT WORKSHEET

DIGESTION IN DOGS

1. Define digestion

2. The tube-like passage from the mouth to the stomach is called the

   ____

3. The four divisions of the ruminant stomach are ______________,

   ______________, ____________ and ____________________________.

4. The part of the digestive system where most digestion is completed and most absorption takes place is the ______________________.

5. How can the dog digest roughage since it has a simple stomach?

   ____

   ____

6. The ______________________ produces bile and is the largest gland in the body.

7. What is the first step in digestion? _________________________

   ____

   ____

8. Discuss how digestion in the stomach of a ruminant is different than digestion in a no-ruminant. ___________________________

   ____

9. What three digestive juices are mixed with the "chyme" when in the small intestine? ____

   ____

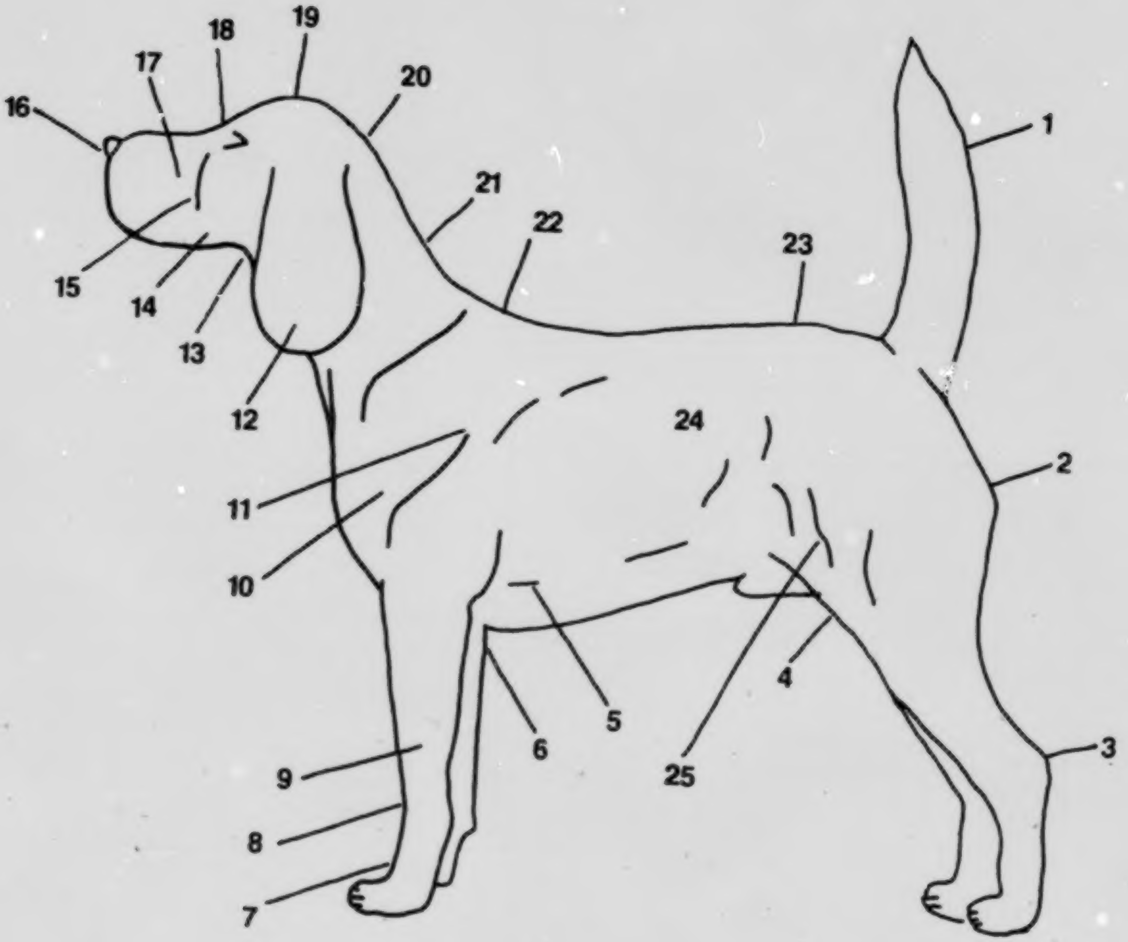
10. Describe how the digested foodstuff is absorbed by the small intestine.

    ____

    ____

STUDENT WORKSHEET

PROFILE OF A DOG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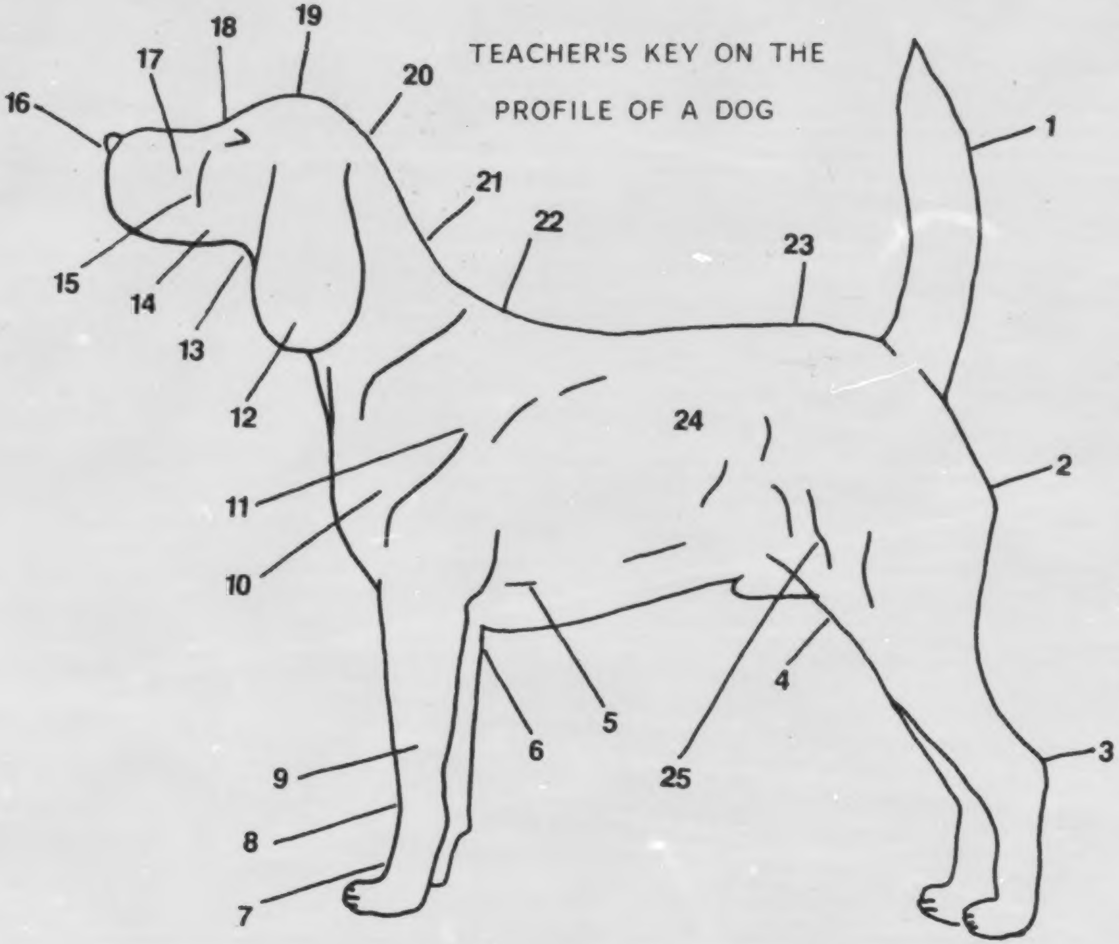
STUDENT WORKSHEET

BREEDS OF DOGS

BREED	ORIGIN (PLace & Date)	Characteristics A. Color B. Size C. Temperament D. Popularity of Breed	Advantages and Disadvantages of Breed

TEACHER'S KEY ON THE PROFILE OF A DOG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1. Brush or flag
2. Point o rump
3. Hock
4. Stifle
5. Chest
6. Elbow
7. Pastern
8. Knee
9. Forearm
10. Point of shoulder
11. Shoulder
12. Ear or leather
13. Dewlap
14. Lips or Flews
15. Cheeck
16. Nose
17. Muzzle
18. Stop
19. Skull
20. Occiput
21. Arch or chest
22. Withers or top of shoulders
23. Hip
24. Loin
25. Tuck

SAMPLE TEST QUESTIONS AND TEACHER'S KEY

(Fill in the blanks)

1. What is the name of the ancestor of the dog? Miacas

2. Identify by name the six breed grouping of dogs
    - a. sporting dogs
    - b. hound breeds
    - d. working dogs
    - d. terrier dogs
    - e. toy dogs
    - f. non-sporting dogs

3. List 4 considerations in selecting a dog for the house
    - a. size of living quarters
    - b. number and age of children
    - c. the way the people live
    - d. owner's temperament

4. Identify the parts of a dog (See separate sheet)

5. List the four common diseases of dogs
    - a. distemper
    - b. hepatitis
    - c. leptospirosis
    - d. rabies

6. List the four common internal parasites found in dogs
    - a. roundworms
    - b. hookworms
    - c. whipworms
    - d. tapeworms

7. List the four common external parasites found in dogs
    - a. fleas
    - b. lice
    - c. ticks
    - d. mites

8. Calculate the cost per pound of dry matter of a 6.5 ounce can of dog food for 33¢ including tax and containing 78% moisture.

    $\$.33 \times \frac{16}{6.5} \times \frac{100}{22} =$ \$3.69 per pound of dry matter

True-False

__T__ 1. The dog and cat have the same ancestors.

__T__ 2. The dachshund is a German name meaning "badger dog."

__T__ 3. The poodle is a non-sporting dog.

__T__ 4. Gruel is another word for a puppy food mixture of milk and puppy food.

__T__ 5. 3 to 4 week old puppies should be fed 1 part milk and 1 part puppy food twice a day for each ounce of body weight.

__F__ 6. Dry dog food contains 20% water.

__F__ 7. Canned dog food contains about 20% protein.

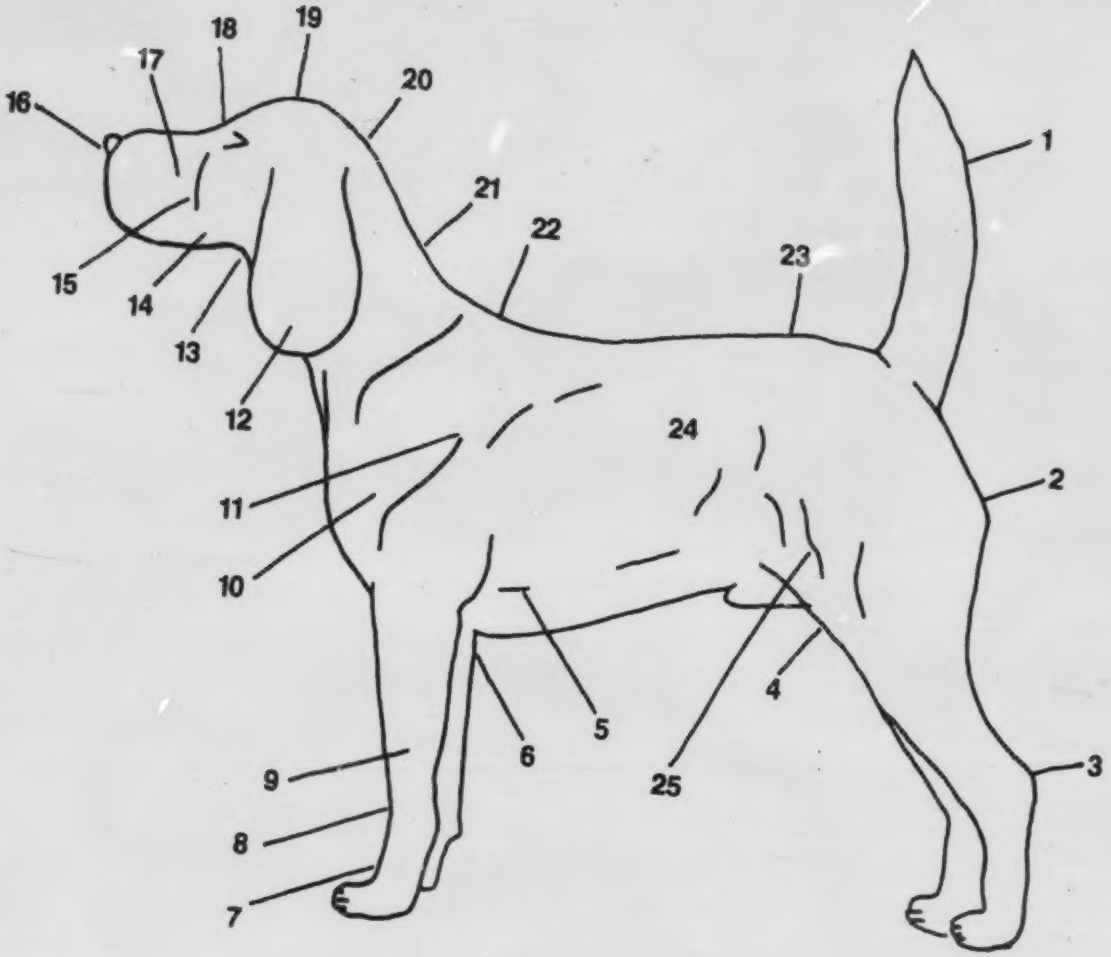
__F__ 8. Chicken bones (legs) are desirable to give to a dog.

__F__ 9. The main purpose of giving a bone to a dog is to add calcium to their diet.

__F__ 10. Dogs should have a constant supply of food in front of them at all times.

PROFILE OF A DOG

IDENTIFY THE FOLLOWING PARTS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UNIT I: URBAN ANIMALS

PROBLEM AREA: CARE AND FEEDING OF THE FAMILY CAT

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshman or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the winter months when working outdoors is not practical.

The estimated instructional time is 10 days for the problem area. If the teaching plan is limited to classroom discussion with little or no practice, the instructional time can be 5 days or less. If students are to be involved in developing skills in this area, the instructional time will have to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The item in this packet are for reference or modification as the instructor adapts this problem area to their local situation.

CREDIT SOURCES:

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The teacher's guide, sample test questions, and student work sheets were developed by Jim Ethridge. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers. The information sheets' author is unknown. The Student Worksheet "Keeping a S.O.E. Cat Record" was adopted from the Illinois 4-H Record Book on "Cat Care Records".

Teacher's Guide

I. Unit: Urban animals

II. Problem Area: Care and feeding of the family cat.

III. At the conclusion of this problem area, students will be able to:

1. Identify problems found in the caring of cats.
2. Determine the needs of a cat in a household.
3. Properly care for a cat (while young or mature or pregnant).
4. Properly feed a cat.
5. Seek out additional information on his or her household pet.
6. Describe the diversity of the cat industry.
7. Name six classes of nutrients and explain their function.
8. Explain the characteristics of a good ration.
9. Describe the major characteristics to consider when selecting a cat.
10. Identify the major parts of a cat.
11. Discuss the common uses of a cat and the characteristics important for each use.
12. Identify internal and external pests of cats.

IV. Suggested Interest Approaches:

1. Attend a cat show.
2. Visit a veterinary hospital.
3. Visit a kennel.
4. Take the class on a field trip to a veterinary clinic, to identify the parts of a digestive system.
5. Bring feed samples into class and have students try to identify the contents.
6. Have available feed tags or food labels and have students identify the nutrient content of each feedstuff.

7. Ask students to explain what they feed their animals and guidelines used in considering food selection

8. Show films from cat associations depicting ideal breed characteristics

9. Use discussion groups to have the class develop a list of characteristics to consider when selecting an animal

V. Anticipated problems and concerns of students:

Lead Question: What do we need to know about feeding and caring for cats in order to accomplish our objectives?

1. What is the history of the cat?
2. What are the major breeds of cats used as household pets?
3. How is a cat selected for the household?
4. How can a cat be housebroken?
5. How should a cat be fed?
6. What accessories are needed for cats?
7. To mate or not to mate? Is this an important question?
8. What needs to be done when the cat is pregnant, and when the kittens are born?
9. How are kittens weaned?
10. What are some tips on grooming of cats?
11. What are some tips for training of cats?
12. What are the major diseases and parasites of cats?
13. What are the symptoms of a sick cat?
14. What are the parts of the digestive system?
15. What are the parts of the ruminant stomach?
16. What is the function of each part of the digestive system?
17. What is a ration? What is a balanced ration?
18. What are nutrients?

19. What is the function of each nutrient?

20. What are the characteristics of a good ration?

21. What is a good ration vs. a balanced ration?

22. What are the differences among concentrates, a roughage and other feed materials?

23. What are "rules of thumb" used in feeding animals?

24. Why do animals need water? What are the water needs of animals? What problms are involved in over-watering animals?

25. When should animals be fed? How much should animals be fed?

26. How does one determine nutritional requirements of animals that are young, adult, pregnant or orphan animals?

27. What is Basic Metabolism Rate (BMR)?

28. What are the main uses of cats?

29. What are the differences among selecting a cat for breeding or for a pet?

30. What terms does one need to know when identifying parts of a cat?

31. What parasites are found in or on cats?

VI. Suggested learning activities and experiences:

1. Distribute VAS Unit 1026a, Digestion in Animals, and have students tentatively answer the identified problems and concerns.

2. Identify and define the important terms related to animal feeding.

3. Show transparencies on the parts of the digestive system and discuss the functions of each part.

4. Identify and discuss the purposes and characteristics of good rations.

5. Use the Student Worksheet "Digestion in Animals". Have students complete and turn in for evaluation.

6. Use the Student Worksheet "General Fon Animal Feeding". Have students complete and turn in for evaluation.

7. Identify nutrition requirements for different stages of growth in various cats.

8. Distribute pictures of animals of different quality and have students select the ones they would purchase. Have the students give reasons for their choice and write them down for discussion.

9. Distribute pictures or show slides of cats for judging. Discuss the factors one should consider in each circumstance.

10. Distribute the Student Worksheet on "Identifying the Parts of the Cat" and have students identify the parts of the cat. Discuss the importance of knowing the parts of the cat when selecting animals for sale, pets, breeding or for show.

11. Show slides or transparencies of "ideal cats" and discuss the important characteristics of each of the different views.

12. Using slides, pictures or live animals, have students judge and place rings of cats for pets, and breeding - using appropriate judging cards and judging booklets.

13. Distribute the Student Worksheet on "Keeping a Cat Record" and have students select an animal for an SOE project and give reasons to support their choice.

14. Have the students identify problems and concerns on selecting and purchasing a cat.

15. Take a field trip or invite a purebred breeder to class to discuss the characteristic they consider when purchasing their animals.

VII. Application of this problem area:

1. The main purpose of this problem area is to introduce the students to the correct feeding and care procedures for cats.

2. This problem area should provide students with the basic information on digestion and the classes and functions of feeds.

3. The students can use this information for identifying animals to consider for an SOE Project.

4. This problem area can prepare students for participation in judging contests and added interest in shows.

VIII. Evaluation:

1. Collect and evaluate student worksheets.

2. Administer and evaluate an objective exam on digestion, nutrients, feeding and selection of cats.

3. Conduct a laboratory examination on identification of feed components.

IX. References and aids:

1. Teacher's Guide

2. Information Sheets on:

    a) Feeding and Caring for Cats
    b) Cat Breeds - Great Britain
    c) Cat Breeds - United States

2. Student Worksheets on:

    a) Breeds of Cats I and II
    b) Taking the Temperature of a Cat
    c) Developing an Animal Health Plan
    d) Maintaining Cat Health and Observing Conditions of the Cat
    e) Keeping a S.O.E. Cat Record
    f) Identifying the Parts of the Cat and Teacher's Key

4. Sample Test Questions and Teacher's Key

5. VAS Unit 1026a "Digestion in Animals"
   VAS Unit 1013a "General Facts on Animal Feeding"

6. Discussion Questions on:

    a) Selecting Breeding Animals
    b) Digestion in Animals
    c) General Facts on Livestock Feeding

INFORMATION SHEET
On
FEEDING AND CARING FOR CATS

What is the history of the Cat?

Scientists theorize that a long extinct animal, the Miacis (pronounced My-a-kiss) a small tree-living animal, was the ancestor of the cat. The Miacis lived 40 to 50 millions years ago and had a long body, an even longer tail and short legs. Like a cat, he probably had retractable claws.

The cat was the center of a religious cult in ancient Egypt, persecuted as a companion of witches in medieval times, and beloved for it's ability to kill rats when the plagues came.

It was not until white settlers arrived from Europe, bringing along with them their domesticated cats, that cats were kept as pets in North America. Colonists, like their European cousins, found cats helped in controlling rats and mice both on the farms and in the towns.

What are the major breeds of cats used as household pets?

Persian

This most popular of the longhairs looks somewhat like a minature lion with his mane across the neck and back and his ears set apart atop his head. The Persian's glossy fur fluffs up all over his body, including his tail or "brush."

The Persian has a massive head, short back, short snub nose, small ears, short tail and large paws. His broad chested body is set rather low on sturdy legs, giving an impression of strength and solidity.

Today there are three divisions of color common to the Persian cat: 1) the solid color in blue, black, red, cream or white; 2) the patched to tabby patterns in many colors; and 3) the silver color called so because of the shimmer of their highly translucent hair which changes shading with light or movement.

There are a few breeders who specialize in distinct types. Cat show catalogues list Blue-eyed Whites, Silver Tabbies, Smokes, Blacks, Red Tabbies, and Tortoiseshells.

The show standard calls for a powerfully built cobby animal with large eyes and a short face and nose.

Color choice is wide, but you will notice that aside from all-white cats, there is only one type among those in any breed standard which shows white -- the tortoise and white. At cat shows you never see black and white, blue and white, or tabby and white cats.

Siamese

Sear Point Siamese

The Siamese is very active, inquisitive, and is a great "talker." These cats have a light body color and darker points (mask, ears, legs, feet, and tail). The Seal Point has a very short, finely textured coat of pale fawn or cream color. All the points are the same shade, a deep seal brown. Brilliant blue eyes present a striking contrast. The Siamese has a finely muscled, dainty body, with hind legs slightly longer than the front.

Blue Point Siamese

The wedge-shaped head, the large ears, pricked forward, and almond shaped, oriental eyes are characteristic traits. The Blue Point has a glacial white coat shaded into a beautiful platinum, with grey-blue points. As with other varieties, eyes are a brilliant blue, with matching nose leather and paw pads.

The Domestic Short-Haired Cat

Silver Tabby

The most common breed of household pet, the American shorthair is recognized in 20 different varieties of color and markings. Full grown cats are medium to large sized and are powerfully built. A short strong neck, broad head and cheeks and full chest add to this cat's strong appearance. A stud will have especially well developed jowls. The cat has a thickish tail which is carried almost level with the back. The coat is of short, thick, even hairs. The Silver Tabby has either green hazel, or lemon colored eyes.

Brown Tabby

Credited with being the earliest domesticated cat in history. The word tabby has come to denote any American shorthair of various colors, but a true tabby cat is banded and varied with black. The brown tabby has luminous orange eyes, which are very round and set wide apart.

Calico

Black, red and/or cream colored patches cover the head, back, sides, and tail of the Calico American Shorthair, with an orange patch on one side of the face. The mottled coat should not be streaked in any way. The nose, throat, legs, and belly are white. Eyes are copper colored or deep orange.

Abyssinian

This cat is presumed to be the oldest known pure pedigreed cat. The body hairs are of two or three different bands of color, giving the cat a "ticked" coat. The coat is usually ruddy brown with dark brown or black tickings and is thick, but silky soft and with a lustrous sheen. The large, broad-based ears are tipped with brown or black. Eyes are almond shaped and are gold, green, or hazel in color. The Abyssinian has a medium long body, lithe and graceful, but which shows well developed muscular strength.

How do you select a cat for the household?

When selecting a cat for the home, it is well to consider the following points:

> For what purpose do you want it? An adult cat would be better if you wanted a working cat or do not have the time to train a kitten. If you want a grown cat that is more responsive to you, start with a kitten.
>
> Do you want a male or female? In this case you must consider numerous factors. Do do you want kittens? If you still prefer a female but not kittens you can have them "altered" so they cannot reproduce. Males are generally more freindly and can also be altered (neutered) to keep them home more by reducing their sex drive.
>
> Is the cat for around the house or to show? The difference here is the cost of your cat. Cats can be registered or not registered depending on your intent. Registered cats are generally more expensive and if shown, more time and care is required.
>
> Are you starting with a kitten? If you are, you must consider that the kitten is very fragile and needs to be handled with care. Make sure that the kitten you select has been naturally weaned and is at least 8 weeks old. Keep it warm and let it explore the new surroundings. Kittens need to be fed often because of their high level of activity and small stomachs.

How do you housebreak a cat?

Cats need to be housebroken because of the offensive odor that develops as a result of cat feces not being disposed of regularly. Cats are one of the easiest animals to housebreak because it is their nature to stay clean. Kittens can be easily housebroken by placing a pan of absorbent material in a quiet spot known by the cat and place him in it when he needs to urinate or eliminate his feces. Materials that are often used include sand, dirt, sawdust, paper, clay, or a commercial cat litter. The latter is the best because it absorbs the odors as well as the moisture. As part of the training you should place the cat in the box after eating, after playing, first thing in the morning and the last thing at night. The box must be emptied and cleaned often or the cat will not use the box. Housebreaking can be accomplished in two or three days. Never punish the cat for soiling furniture because his memory span is too short. Clean and deodorize the spot instead so he will not return thinking it is the right spot to eliminate his waste.

What are different ways to feed a cat, what should be fed, how much and how often should the cat be fed?

Cats, like humans, are omnivorous. They eat meat but need vegetables, also, to have a balanced meal. Cats need a high protein, high-fat diet for good growth. If you want to be sure your cat is getting good nutrition, buy a commercial cat food. Companies have been testing and improving their products until they meet or exceed the needs of each cat. There are four major divisions of commercial cat food available:

> Dry cat food that contains about 30 percent protein, 8 percent fat, and 9-10 percent moisture. For adults cats, feed 1 to 1 1/2 ounces twice a day.
>
> Speciality cat food, in the little flat cans, usually contain from 10 percent to 23 percent protein, 2 percent to 6 percent fat, and about 75 percent moisture. Vitamins and minerals are added to balance the nutrition. Adult cats should be fed 2 1/2 to 4 ounces of the food twice a day.
>
> Maintenance cat food, in the tall cans, usually contains about 10 percent protein, at least 2 percent fat, and about 75 percent moisture.
>
> Soft-moist cat food, this is the pouch packaged food. Normally containing at least 27 percent protein, 7 percent fat, and 30 to 34 percent of moisture. One packet provides one feeding for the adult cat. Feed twice a day, two packets needed.

Some "do nots" about feeding your cat. Do not feed your cat table scraps. He may like them but they lack the balanced nutrition he needs, and bones from the table scraps can be hazardous. Do not feed him the same things every day. He wants variety; give it to him. Some foods can be toxic if given often. Liver can cause vitamin A toxicity, raw egg white can destroy the vitamin biotin, and raw fish can cause a deficiency of the vitamin thiamine.

When feeding a cat, always have a dish or bowl of fresh, clean water available. It is very important, and you must remember that milk is not a substitute for water, milk is a food. Regularity is another good point, the cat should be fed at the same times each day, or else the irregularity will affect the cat in a detrimental way.

Kittens must be considered separately from adult cats. For six to eight week old kittens, a mixture of warm milk and a little regular cat food will serve as a good starter meal. Then gradually reduce the milk and increase the cat food until the kitten is eating only the cat food. This takes about two weeks. Kittens need a different eating schedule, too. They should be fed four times a day, instead of two, because of their small stomachs.

What accessories are needed with cats?

Cats are creatures of comfort. They like to be warm and cozy, in other words, they like to stay in the house.

If the cat is to stay in the house, the following are some things which may be needed:

- Litter pan(s) and absorbent litter
- Collar and identification tag
- Toys
- Food and water bowls
- Scratching post
- Grooming aids
- Food
- First aid needs (bandages, antiseptic, gauze)
- Bed

These items are suggested if the cat spends most of his time indoors. The litter pan, food and water bowls, food, and scratching post would be considered essential. The bed could be a purchased fancy one, or just a box lined with something warm and CLEAN. If the bed does not stay clean he may choose to sleep elsewhere.

Should a cat be bred? If so, when?

In the United States today there are approximately 33 million cats that are either in animal shelters or abandoned. This leads to a cost of $65,000,000 to the taxpayers. If a household has a female cat, it is likely that one day there will be a litter of kittens. This household has the responsibility of keeping, giving away or otherwise disposing of the kittens. There is a quick, painless, inexpensive operation that can eliminate the birth of unwanted kittens. In males it is known as neutering or castrating. A neutered male remains gentle, reliable, and free of odor after the operation. He also strays less from home in search of females. The same result is achieved when females are spayed. After the operation, the female will be incapable of producing offspring. If someone feels that motherhood is a great moment in a cat's life, they are wrong. A cat's pregnancy, delivery, and nursing are very painful to the mother and she would be better off never to have kittens.

Planned parenthood applies to cats also. Cat breeders obviously do not want a neutered or spayed animal because of their inability to produce offspring. For proper breeding, the following physiological data must be considered.

Factor	Technical Terminology
1. Age to puberty	6-15 months
2. Breeding season	2-3 times a year; mostly from June to August
3. Estrous cycle	Polyestrus, seasonal, induced ovulation
4. Length of sexual cycle	Irregular, from 15 days to several months

5.	Duration of heat	About 4 days in presence of male, 10 days otherwise
6.	Ovulation	Induced by copulation, both ovaries 24-36 hours post copulation
7.	Time of copulation	Around third day of the estrous cycle
8.	Fertilization time	Occurs 2 days after copulation
9.	Gestation period	52-69 days, average 63 days
10.	Weaning age	Depends on breed, 5-9 weeks
11.	Beginning of new estrous	About 2-3 weeks after weaning
12.	Breeding life	Female 4 year, male 5 years

Proper planning is the key so the breeder can be prepared for each breeding season and each birth time.

What needs to be done when the queen is pregnant, when the kittens are born, and for the next 2 to 3 days after birth?

For the first 8 of the 9 weeks of pregnancy, the female (queen) should be allowed to move about normally. The only changes in the normal routine would be to increase her amount of food, giving her warm milk and increase her intake of vitamins and iron. During the early part of pregnancy, immunization records should be checked to see if the cat has been innoculated against distemper and rabies. This should be done because temporary resistance is passed on through her milk to the kittens. The last week will be the time when the female will be looking for a nest. Provide a nest for her, an empty box lined with old towels will be sufficient if it is located in a warm, dark place in the house.

Labor follows the same pattern as in other animals:

1. Restlessness
2. Vaginal discharge
3. Stomach dropping
4. Labor pains
5. Panting
6. Excessive water consumption

But, if labor continues for 18 - 24 hours without results, a veterinarian should be consulted.

The size of a litter could range from one to six kittens with an average of about three. When the kittens start to emerge their normal position would be head first with legs alongside, somethimes they will be breeched, meaning they are born rear first. Watch the birth carefully, only assisting in an emergency; the mother cat knows what she's doing.

Watch and make sure the cat passes a placenta after each kitten, she will eat all afterbirth, and clears the membrane around the kitten. If the newborn kitten has trouble breathing hold his legs, invert him, and tap on his back to clear his lungs and throat. Then be sure to disinfect the navel cord.

After the kittens are born make sure they all nurse. The first milk of the mother is the richest in antibodies and nutrients so it is important that all the kittens get some. Give the weaker kittens extra milk and vitamins so they can catch up to the others. Do not worry about their eyes being closed, they will open in about 10 days.

How are kittens weaned?

At about 3 to 4 weeks of age, the kittens will begin to develop their first set of teeth (milk teeth). When the teeth come in they can begin eating small amounts of cat foot mixed with warm, evaporated milk. By the time they are 7 to 8 weeks old they will be able to eat all their meals away from the mother cat. At this time you also need to gear down the mother, if she has been eating heavily to feed the kittens. After weaning, cut the ration to about 1/4 of the normal ration then gradually increase it keeping a careful watch on the mother to see if her udders have dried and her weight has remained normal.

What are some tips on grooming cats?

Brushing is broken into two categories: long hair and short hair. The long hair breeds need to be brushed twice a day with a steel comb so they will not shed on your furniture and the brushing will also stimulate hair follicles, and give the cat a sleaker look. The short hair breeds need to be brushed only once a day with a long bristled brush for the same reasons as the long hair.

Bathing should be restricted to times of emergency, unless it is a pedigreed show cat. Bathing removes the protective oils on the skin and opens the cat to a cold. If the cat must be bathed, use warm water and a cat shampoo in a draft free room, wash quickly, and dry thoroughly. Dry shampoos work well on cats also.

Clipping the cats nails is a temperamental point. If your cat stays outside most of the time nature will clip the nails for you. If your cat stays indoors clip the nails according to directions given by your veterinarian. The closest the cut should be is within 1/8 of an inch from the blood vessel of the nail.

What are the major diseases and parasites of cats?

When your cat is sick he may develop some of these symptoms:

Dull, rough coat, with excessive shedding
Listless, sleepiness
Bad breath odor
Loss of appetite

Red, watery eyes
Vomiting, coughing, sneezing
Body swelling, lumps increasing in size

The most common ailments are ones that can be avoided by proper care and a watchful eye.

Infectious Enteritis

It has been called feline distemper and is almost always fatal. The symptoms appear quickly and violently. This disease is almost incurable. The best way to combat it is to immunize when the kitten is six to nine weeks old.

Rabies

Cats are as susceptible to rabies as other animals but should be vaccinated early. Rabies comes in three stages. The first stage will be only a slight change in the temperment, the cat will isolate itself and display snapping behavior. The second stage is much more noticable. The eyes and voice will change, the cat will make strange movements, and the muscles will show signs of paralysis. The third stage is an advancement of the second; total paralysis, loss of voice, and the tongue hanging dryly from the mouth. The total process results in death in four to six days.

Pneumonitis

This is a severe disease of the upper respiratory tract. The symptoms are a high fever (normal temperature is 101.5°F.), sneezing, runny eyes, wheezing, and drooling. The disease can be combated with antibiotics, but the best method of fighting the disease is to vaccinate against it annually. If your cat has it be careful because pneumonitis is very contagious to humans.

Feline Infectious Anemia

It is caused by a microscopic parasite attacking the red blood cells thus causing anemia. Its symptoms are fever, depression, loss of appetite, emaciation, and possibly jaundice. It attacks cats from one to three years old and is of much higher frequency in males than in females. It can be treated by using steriods, antibiotics and blood transfusion but over 50 percent of all cats that contract it still die. It possibly is carried by fleas.

Hairballs

This condition is common beause cats are continually cleaning themselves and swallowing the hair. The hairball can cause constipation and stomach or intestinal disorders. So they should be removed either through surgery for a large hairball or by giving the cat milk of magnesia or another constipation remedy.

Internal Parasites

The four most common internal parasites found in cats are: 1) the hookworm; 2) the tapeworm; 3) the roundworm; and 4) the whipworm.

Hookworms are about half an inch long and attach themselves to the wall of the intestine and such blood.

Tapeworms are transferred by fleas, rodents, and other wild animals that have eaten the eggs of the tapeworm. Some symptoms of tapeworms are: 1) the cat will drag his rear end on the floor; and 2) the cat will lose his body condition becoming weaker and thinner.

Roundworms cause the cat to be listless. Diarhea or constipation, a pot belly and loss of weight are additional symptoms of the disorder. Coughing spells and fever are symptoms that the roundworms are far advanced.

The best way to combat these parasites is to maintain high sanitary conditions.

General symptoms of a cat's having any type of worms include a dull coat, inflamed eyes, coughing and vomiting. Another would be if the cat eats excessively but does not grow.

Treatment of worms is simple and recovery for the cat is fast if done properly. Consult your veterinarian if problems arise.

External Parasites

"Fleas are small, hard shelled, very active insects that live on cats and other animals. They feed on blood and cause local discomfort, causing the cat to scratch. Fleas are also notorious for carrying diseases. There are many good powders, sprays and collars available that can help combat fleas, but be sure to de-flea your cat outdoors to keep dead fleas off the floors. If fleas are found, spray flea killer throughout the house for several days to eliminate the fleas that escaped, and their eggs.

Flea powder will also eliminate lice.

Ticks are eight-legged hard-shelled arachnids, similar to spiders, which burrow their head into a cat's skin and feed on his blood. Irritation and infection are the main concerns as well as a chance of anemia due to blood loss. Ask your veterinarian what would be the best way to remove the ticks.

Ear mites are little insects that burrow into the ears of cats causing great irritation. The cat will scratch his ears and shake his head frequently. If you think your cat has ear mites, consult your veterinarian because the final result could be ear infection and deafness.

Skin Diseases

Mange is characterized by excessive shedding and baldness. It is caused by mites burrowing into the skin killing and cutting the hair. The veterinarian has effective treatments if the problem is diagnosed early.

Ringworms appear as oval bare patches on the cats starting in the head region. It can be treated with iodine but if it persists call the veterinarian.

Exzema is often caused by a hormonal imbalance or an allergy on the part of the cat to something in his diet or environment. It appears as intense itching accompanied by falling fair, a dry, scaly skin, and sometimes open sores. Consult your veterinarian for treatment.

INFORMATION SHEET
CAT BREEDS - GREAT BRITAIN

Long-Haired Cats

- Black
- White with Blue Eyes
- White with Orange Eyes
- Blue
- Red Self
- Cream
- Smoke
- Tortoiseshell
- Tortoiseshell and White
- Blue Cream
- Bicolored
- Brown Tabby
- Red Tabby
- Silver Tabby
- Chinchilla
- Colorpoint
- Birman Cat (Sacred Cat of Burma)
- Any other color

Short-Haired Cats

British

- Black
- White with Blue Eyes
- White with Orange Eyes
- British Blue
- Cream
- Tortoiseshell
- Tortoiseshell and White
- Tabbies:
  - Brown
  - Silver
  - Red
  - Mackerel (any other variety)
- Sootted
- Blue Cream
- Bicolored
- Manx

Foreign

- Russian Blue
- Abyssinian Normal
- Abyssinian Red
- Burmese
- Burmese Blue
- Chestnut Brown Foreign
- Siamese:
  - Seal Point
  - Blue Point
  - Chocolate
  - Lilac Point
  - Tabby or Lynx Point
  - Any other color

  - Red Point (Siamesetype)
  - Cornish Rex-Coated (Gene 1)
  - Devon Rex-Coated (Gene 2)

INFORMATION SHEET
CAT BREEDS - UNITED STATES

The American Standards are slightly different, and also the subdivisions:

Long-Hair

Solid color cats:

- White
- Black
- Blue
- Cream
- Red
- Peke-Faced Red

Tabby and Tortie:

- Brown Tabby
- Tortoiseshell
- Tortoiseshell-Peke-Faced
- Calico (Tortie and White)
- Blue Cream

Silver

- Chinchilla Silver Tabby
- Shaded Silver
- Blue and Black Smoke

Minalayan
Maine Coon Cat

Short-Hair

Domestic Short-hair
Manx
Abyssinian
Burmese
Russian Blue (Maltese)
Rex Siamese:
Siamese:

- Seal Point
- Chocolate Point
- Blue Point
- Frost Point or Lilac Point
- Red Point
- Lynx Point

STUDENT WORKSHEET
BREEDS OF CATS

I

Develop a notebook containing 15 different breeds of cats. The notebook should contain a picture, characteristics, and origin of each breed. The project is due in two weeks.

STUDENT WORKSHEET
BREEDS OF CATS

II

BREED	ORIGIN (PLACE AND DATE)	CHARACTERISTICS A. Color B. Long or Short Hair C. Size D. Temperment	ADVANTAGES AND DISADVANTAGES OF OF BREED

STUDENT WORKSHEET
TAKING THE TEMPERATURE OF A CAT

I. Equipment:

- A. Clinical Thermometer
- B. Soap
- C. Disinfectant

II. Procedure:

- A. Shake down thermometer
- B. Lubricate with oil or soap
- C. Insert in rectum along lining of the bowl
- D. Allow 2-3 minutes for temperature to be obtained
- E. Remove thermometer and read
- F. Dip thermometer in disinfectant

III. Observations:

STUDENT WORKSHEET
DEVELOPING AN ANIMAL HEALTH PLAN

Using information provided in class develop a plan for maintaining a cat's health. Factors on the information sheets may be used as a guide. Complete and turn this project into the instructor for evaluation in 5 class days.

STUDENT WORKSHEET
MAINTAINING CAT HEALTH
OBSERVING CONDITIONS OF THE CAT

Using cats in a class laboratory, complete the following chart. Information on the information sheet may be used as a guide. Complete and turn in to the instructor for evaluation.

	1	2	3	4	5	6
Eyes						
Hair/coat						
Temperature						
Pulse						
Respiration						

STUDENT WORKSHEET
KEEPING A S.O.E. CAT RECORD

Add these sheets to your S.O.E. Record Book.

Date project started ________ Years enrolled in this project ________

INVENTORY AT BEGINNING OF YEAR
(Cats, Supplies, and Equipment)

	Value
Cat (breed)*	
Litter Pan	
Cage or Bed	
Equipment and other items (list)	

Total Value ________

* Alley Cat is called a Domestic Tabby Cat

HEALTH RECORD
(Record the vaccines, treatment and care your cat has received. Include Rabies, Distemper and Pneumonitis shots)

Date	Item	Date	Item

List comments from your veterinarian ________________________________

____

GUIDE FOR HOME INSPECTION OF CATS

Name of Cat ______________

__________ 1st Date __________ 2nd Date __________ 3rd Date __________

Inspections should be made at least three times during the year. The first inspection should be made within one month after you assume responsibility.

Points to Check	Inspections, Indicate			Remarks
	1st	2nd	3rd	
CONDITION OF COAT G-Good, F-Fair P-Poor				
CONDITION OF EYES C-Clear, Cl-Cloudy D-Discharge				
CONDITION OF EARS C-Clean, D-Dirty I-Inflamed				
CONDITION OF BODY N-Normal, O-Obese T-Thin				
CONDITION OF TEETH C-Clean, S-Stained T-Tartar, B-Broken				
COLOR OF GUMS Pink - Healthy Pale - Anemic				
LEG STRUCTURE S-Straight D-Deformed				
TEMPERMENT F-Friendly, S-Shy A-Aggressive				

EXPENSES

(Food, litter, veterinary services, equipment purchased, etc.)

Date	Item	Cost	Date	Item	Cost

Total ____________

SHOW RECORD

Date	Show	Remarks	Placing

If your cat is a female, list dates that she is in season ____________

____

Housing - Outdoors Only ________ Indoors Only ________ Both ______

List some facts you learned in this project ____________

____

____

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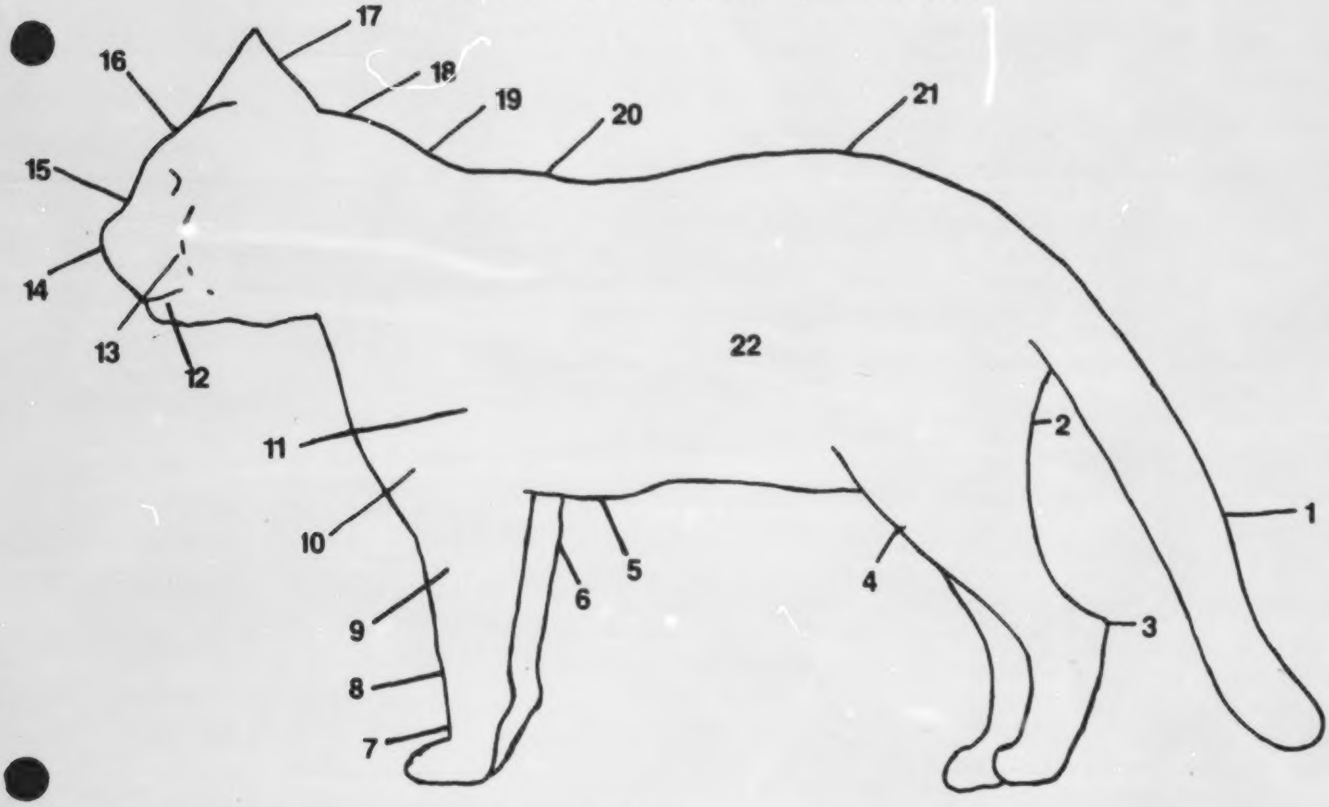
STUDENT WORKSHEET
IDENTIFYING THE PARTS OF THE CAT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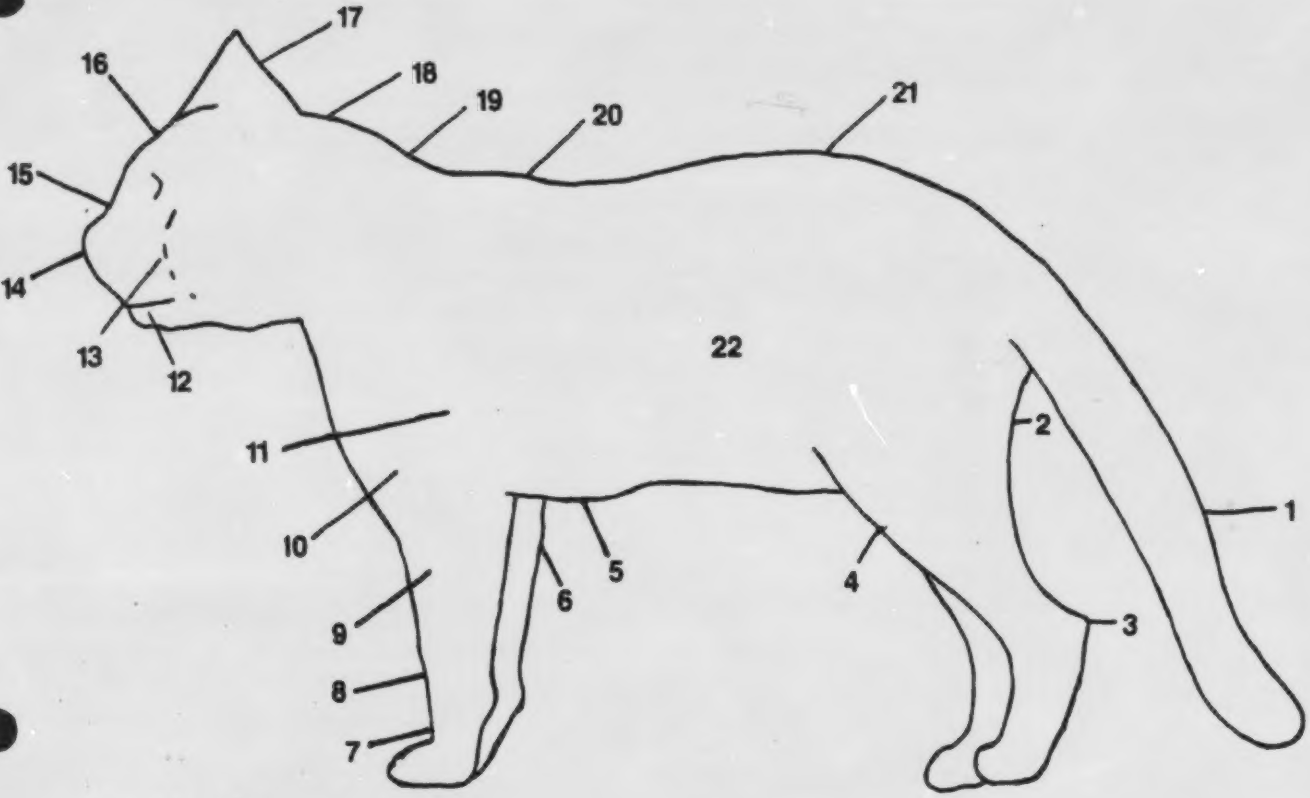
TEACHER'S KEY TO STUDENT WORKSHEET IDENTIFYING THE PARTS OF THE CAT



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1. Tail
2. Point of rump
3. Hock
4. Stifle
5. Chest
6. Elbow
7. Pastern
8. Knee
9. Forarm
10. Point of Shoulder
11. Shoulder
12. Lips or flews
13. Cheek and Muzzle
14. Nose
15. Stop
16. Skull
17. Ear
18. Occiput
19. Neck
20. Withers or Top of Shoulders
21. Hip
22. Loin

DISCUSSION QUESTIONS
SELECTING BREEDING ANIMALS

1. What factors are considered in selecting cat breeding stock?

2. What is type or individuality of a cat breeding animal?

3. What is meant by desirable breed characteristics?

4. What factors are considered when using the term "desirable physical characteristics"?

5. What can be determined by handling the animal?

6. What factors should be considered when selecting an animal for production? for show? for a house pet?

DISCUSSION QUESTIONS
DIGESTION IN ANIMALS
(Refer to Vas Unit 1026a)

1. Define digestion.

2. The tube-like passage from the mouth to the stomach is called the ____________________________________.

3. The four divisions of the ruminant stomach are ________________, ____________________, ____________________ and ________________.

4. The part of the digestive system where most digestion is completed and most absorption takes place is the __________________________________.

5. How can the horse digest roughage since it has a simple stomach?

6. The __________________ produces bile and is the largest gland in the body.

7. What is the first step in digestion?

8. Discuss how digestion in the stomach of a ruminant is different than digestion in a non-ruminant.

9. What three digestive juices are mixed with the "chyme" when in the small intestine?

DISCUSSION QUESTIONS
GENERAL FACTS ON LIVESTOCK FEEDING
(Refer to VAS Unit 1013a)

1. Why do animals need nutrients?

2. List and give the functions of the six classes of nutrients.

   a.

   b.

   c.

   d.

   e.

   f.

3. What is the difference between a "good ration" and a "balanced ration"?

4. List some recommended practices in providing water for livestock.

5. Feed costs make up about ____________ percent of the total cost of producing an animal.

SAMPLE TEST QUESTIONS AND TEACHER'S KEY

1. What animal was the ancestor of the now domestic cat? Miacis

2. Identify the four most common breeds:

   a. Persian c. Short hair

   b. Siamese d. Abyssinian

3. Identify four considerations when selecting a house cat:

   a. What is the purpose of cat?
   b. Do you want a male or female?
   c. Do you want to show your cat?
   d. Do you want to begin with a kitten?

4. What is the normal temperature of a cat? 101.5°

5. The average litter size for queens are 4 to 5 kittens.

6. At about 3-4 weeks of age kittens begin to develop their milk teeth.

7. A typical house cat should be bathed 0 times per week.

8. The closest the cut should be made in trimming the nails of a cat is within 1/8 of an inch(s) from the blood vessel of the nail.

9. Identify by name the 4 most common ailments found in cats.

   a. Enteritis (commonly called distemper) c. Pneumonitis
   b. Rabies d. Anemia

10. Identify ny name the 4 most common internal parasites found in cats.

    a. Hookworms c. Roundworms
    b. Tapeworms d. Whipworms

11. Identify by name the 4 most common external parasites found on cats.

    a. Fleas c. Ear mites
    b. Ticks d. Lice

12. Identify by name the three most common skin diseases found on cats.

    a. Mange c. Eczema
    b. Ringworms

MATCHING

Match the following terms with the appropriate description:

D	1.	Purebred	A.	Gray hair coat
F	2.	Bloodline	B.	Table presenting a line of ancestors
I	3.	Castration	C.	Mature female cat
H	4.	Get	D.	Ancestors are all of the same breed
B	5.	Pedigree	E.	Male cat
E	6.	Tom Cat	F.	Family line of breeding
G	7.	Neutered	G.	Missing their sex organs
C	8.	Queen	H.	Offspring of animal
J	9.	Piebald	I.	Removal of the testicle of the male
A	10.	Grizzle	J.	Two or more colors in patches

TRUE-FALSE

T 1. A cat is ominvorous - that is, they eat meat and vegetables.

T 2. Dry cat foods contain about 9-10% moisture.

T 3. Adult cats should be fed 2 1/2 to 4 ounces of specialty cat food twice a day.

T 4. Maintenance cat food contains about 75% moisture.

F 5. It is recommended that you feed a cat liver on a continuous basis.

F 6. Cats should be fed raw fish on a continuous basis.

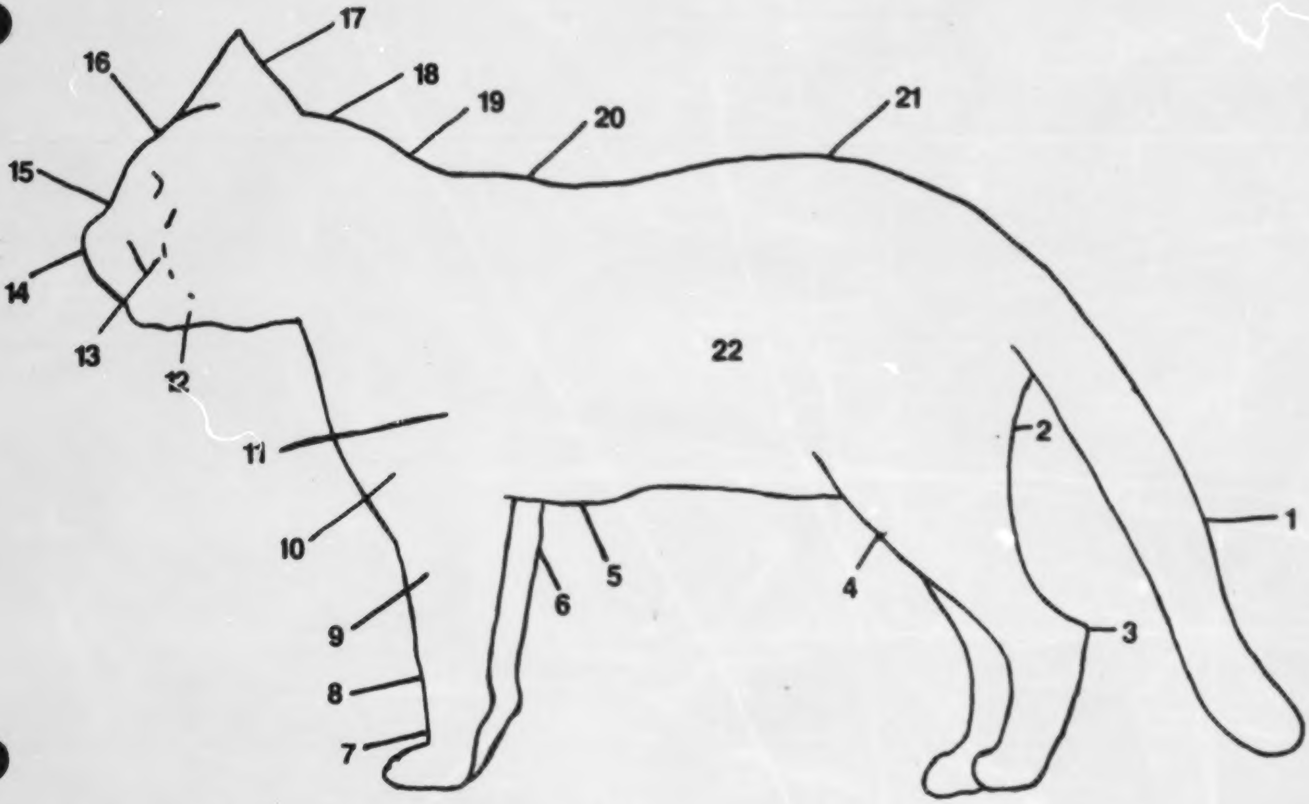
F 7. Milk is a suitable substitute for water in a cat's diet.

F 8. Kittens should be fed twice a day.

F 9. The breeding season of cats is usually from September to December.

T 10. Kittens are usually weaned from the mother between the 5th and 9th week.

Match the term with the appropriate number in the profile of a cat.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______ Tail
______ Point of rump
______ Hock
______ Stifle
______ Chest
______ Elbow
______ Pastern
______ Knee
______ Forearm
______ Point of shoulder
______ Shoulder
______ Lips or flews
______ Cheek and muzzle
______ Nose
______ Stop
______ Skull
______ Ear
______ Occiput
______ Neck
______ Withers or top of shoulders
______ Hip
______ Loin

TRUE (+) - FALSE (0)

__+__ 1. A nutrient is a chemical that aids in the support of life.

__0__ 2. Carbohydrates provide a major source of proteins.

__0__ 3. Only 25% of the dry weight of most grains and roughages is made up of carbohydrates.

__+__ 4. Proteins are compunds made up of amino acids.

__0__ 5. There is 2 1/4 times as much energy in carbohydrates as in fats.

__+__ 6. Minerals can be found in teeth, bones, and the body's enzyme systems.

__0__ 7. B_{12} is a mineral.

__+__ 8. Water is very important in the body, functioning as an excellent solvent.

__+__ 9. Water is an often neglected nutrient.

__+__ 10. One of the first things a ration must do is maintain life by keeping the body at a constant weight and temperature.

MULTIPLE CHOICE - (Make appropriate choice of A, B, C, or D)

__D__ 1. Aminals need nutrients for:

A. Growth
B. Maintenance
C. Finishing
D. All of the above

__A__ 2. A major nutrient:

A. Carbohydrates
B. Amino acids
C. Fatty acids
D. Both A and C

__A__ 3. Feeds high in the following are the least expensive in supplying the needs for finishing:

A. Carbohydrates and fats
B. Amino acids and proteins
C. Minerals
D. Vitamins and minerals, to provide the energy needed for the formation of fat

C 4. A ration is the amount of feed allowed an animal during a:

A. 12 hr. period
B. Week's time
C. 24 hr. period
D. None of the above

D 5. For growth, animals need:

A. Proteins
B. Minerals
C. Vitamins
D. All of the above

D 6. The amount of crude protein in corm is approximately:

A. 50%
B. 15%
C. 20%
D. None of the above

A 7. The amount of crude protein in soybean meal is approximately:

A. 50%
B. 15%
C. 20%
D. None of the above

MATCHING

F 1. Nutrient
G 2. 10%
J 3. 50%
A 4. Minerals
H 5. Vitamins
I 6. Water
B 7. Carbohydrates
C 8. Fats
E 9. Proteins
D 10. Ration

A. Constituents of bones, teeth, and organs
B. Major source of energy
C. Glycerol
D. The amount of feed allowed an animal in 24 hrs.
E. Amino acids
F. A chemical element or compound that aids in the support of life.
G. % crude protein of corn
H. B_2, B_{12}
I. Often neglected nutrient
J. % crude protein of soybean meal

COMPLETION (Write appropriate information or words to complete statements.)

1. Compounds made of amino acids are proteins.

2. Esters of fatty acids and glycerol are fats.

3. The six nutrients are carbohydrates, proteins, fats, minerals, vitamins, water.

4. Animals need nutrients for 5 basic functions. They are maintenance, growth, finishing, production, reproduction.

5. The amount of feed allowed an animal during a 24 hr. day is a ration.

6. A chemical element or compound that aids in the support of life is a nutrient.

7. Carbohydrates provide the animal with its major source of energy.

8. A feed that is high in fiber and low in digestible energy is a roughage.

9. Water is important in the body, functioning as a regulator of body temperature and a transporting medium for waste products.

10. A ration must maintain life by keeping the body at a constant weight and temperature.

ESSAY QUESTION

1. What are the characteristics of a good ration? Briefly discuss each characteristic.

   (refer to page 2 VAS Unit # 1013a) "General Factors on Livestock Feeding"

UNIT I: URBAN ANIMALS

PROBLEM AREA: CARE AND FEEDING OF THE FAMILY HORSE

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshmen or beginning students in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the spring semester as it becomes possible to work outdoors.

The estimated instructional time for this problem area is 5 to 10 days depending on how far the teacher wishes to go in developing feeding, riding, and grooming skills at the first year level. If the teaching plan is limited to classroom discussion with little or no practice or observation, the instruction can be 5 days or less. If the students are to be involved in other activity exercises, the instructional time will need to be increased.

If is also suggested that local stables be contacted for participation in the care and handling of horses and the various activities involved with horsemanship.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this packet are for reference or modification as instructors adapt this problem area to their local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide and student worksheets were developed by Jim Ethridge. Test Questions were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit - Urban animals

II. Problem area: Care and feeding of the family horse

III. Objectives: At the close of this problem area students will be able to:

1. Describe the major characteristics to consider when selecting a light horse.
2. Identify the major parts of a horse.
3. Identify and properly use tools used in feeding and grooming a light horse.
4. Describe job opportunites related to the light horse industry in Illinois.
5. Describe the safe handling of a riding horse.
6. Identify the age of a horse.
7. Describe the proper feeding of the horse.
8. Identify the proper shelter for a horse.
9. Describe the importance of proper conditioning and exercise for the horse.
10. Demonstrate the proper techniques and methods of grooming horses.
11. Identify basic horsemanship.
12. Groom a horse for a show.

IV. Suggested interest approaches:

1. Take a field trip to an animal production farm and have the owner discuss the characteristics he or she uses to determine which horses to cull or keep.
2. Show films from breed associations depiciting ideal breed characteristics of horses.
3. Use discussion groups to have the class develop a list of characteristics to consider when selecting a horse.
4. Show slides of present and past students supervised occupational experience programs in horses, illustrating the importance of selecting a horse for the S.O.E. Project.

5. Have a local farrier demonstrate trimming and shoeing.

6. Have students set up a display of tools for hoof trimming and shoeing as well as equipment for vaccination and injections.

V. Anticipated problems and concerns of students:

1. What characteristics does one look for when selecting a riding horse?

2. What are the main uses of horses?

3. What are the major parts of a horse?

4. What are the differences among selecting an animal for breeding, or for a companion animal?

5. How do you locate businesses that sell quality horses?

6. How does one judge quality in riding horses?

7. What terms does one need to know when identifying parts of a horse?

8. How do I saddle, bridle and ride a horse?

9. How do I feed my horse?

10. What are the breeds of light horses?

11. What shelter should be provided for a horse?

12. How do I train a young horse?

13. What equipment do I need to care for my horse?

14. What safey precautions should be observed around horses?

VI. Suggested learning activities and experiences:

1. Have a local horse breeder as a guest speaker in class--a veterinarian might be an alternative.

2. Develop a handout for the students to use in labeling with the parts of the horse.

3. Take a field trip to a local horse stable to participate and observe proper grooming practices.

4. Have a local horseman bring in registration papers of horses.

5. Provide a display of tools used by horsemen - discuss each tool and how it is used.

6. Conduct field trip to a breeding farm to observe the breaking of a foal.

7. Show films on halter breaking and training horses.

8. Have students give demonstrations on grooming of horses; also give demonstrations on the clipping of horses.

9. Discuss the reasons for the concentration of specific kinds of horse enterprises in different areas of the state.

10. Prepare a worksheet for the study of horse breeds and their characteristics. Include major breeds, place or origin characteristics and availability.

11. Arrange a field trip to a horse show to observe a variety of kinds and breed of animals. Ask owners to discuss the characteristics of their specific breeds.

VIII. Evaluation:

1. Collect and evaluate worksheets and Job Sheets.

2. Administer and evaluate a test on selecting animals.

3. Have the students perform activities appropriate to the objectives of the locally developed and adjusted problem area.

IX. References and aids:

1. Teacher's Guide

2. VAS Unit 1047 - Horses and Horsemanship

3. Samples Test Questions

4. Samples Test Questions and Teacher's Key

5. Student Job Sheets on:

   a. Cleaning a Horse's Hoof
   b. Breeds of Light Horses
   c. Saddling a Horse
   d. Bridling a Horse
   e. Mounting a Horse

6. Information Sheets On:

    a. "General Horse Terms"
    b. "Classification of Horses According to Type and Use"

7. VAS Slide Set 150 "Good Horsemanship"

8. VAS Slide Set 151 "Preparing the Horse for Riding"

9. VAS Set of Horse Transparencies 1, 8, 11, 14, 22, 23, 24, 29

10. VAS Set of Animal Nutrition Transparencies 2, 3, 8, 11, 41, 53, 71

11. Illinois Cooperative Extension Service 4-H Office, 47 Mumford Hall, Urbana 61801

    a. "Horses and Horsemanship 4-H Horse Program" 48p
    b. "Illinois 4-H Horse and Pony Record" 4p
    c. "Horse Science 4-H Horse Program 46p
    d. Illinois 4-H Horsemanship Project 445a Novice Unit 10p
    e. Illinois 4-H Horsemanship Project 445b Horseman Unit 10p
    f. Illinois 4-H Horsemanship Project 445c Horseman Unit 17p
    g. Sample Stable Record Sheet 1p
    h. Leader's Guide For 4-H Horsemanship Units 1p

INFORMATION SHEET

GENERAL HORSE TERMS

Abortion: The expulsion of the fetus before it is capable of living outside of the uterus.

Action: The manner in which a horse moves its feet and legs, as at the walk, trot, etc.

Artificial Insemination: The mechanical injection of male semen into the womb of the female with a special syringe-like apparatus. The process begins with the collection of semen from the male. This method is used extensively in dairy cattle.

Balanced Ration: A ration which furnishes all the necessary nutrients in the proportions and amounts needed by the animal for normal functioning and growth.

Balling Gun: A long, metal instrument with a cup-like depression at one end for placing solid medicine in the back of the mouth so that the medication is swallowed without being chewed.

Barren: Sterile, incapable of producing offspring.

Bitting Rig: A combination of bridle, harness and crouper. Used to teach the horse to flex at the poll.

Bloom: Usually refers to the hair that is clean and glossy, denoting a healthy appearance.

By: Sired by.

Canter: The Canterbury gallop. A three-beat gait, a moderate, easy collected gallop.

Cast: To lie down or roll close to a wall so it is impossible or difficult to get up without assistance.

Castration; The removal of male reproductve organs to reduce sexual activity.

Collected: A controlled gait.

Concentrate: Feeds high in total digestible nutrients and low in fiber.

Dam: The female parent of the horse.

Digestible Protein: That part of the protein in a feed which the animal can digest, usually 75-85%.

Equine: Of or pertaining to a horse.

Farrier: A horseshoer.

Far Side: The right side of the horse.

Favor: To limp slightly.

Filly: A female foal up to 3 years of age.

Foal: Filly or colt under one year old.

Forehand: The fore part of the horse; the forelegs, head and shoulders.

Gelding: An altered or castrated horse.

Gestation Period: Period of pregnancy, usually about 11 months in the horse.

Get: The progeny of a stallion.

Green Horses: One with little training.

Hand: A measure of the height of the horse; a hand's breadth equals 4 inches.

Herd Bound: A horse who refuses to leave a group of other horses.

Hobble: Strap that fastens the front legs together to restrain the horse.

Jack: Male donkey or ass.

Light Horse: Any horse used primarily for riding and driving; all breeds except draft breeds.

Longe: A strap, rein, or rope about 3 feet long, attached to the halter. Used in breaking or exercising.

Mare: A female horse.

Mule: A cross between a jack and a mare.

Near Side: The left side of the horse.

Off Side: The right side of the horse.

Open: In breeding, a mare that is not pregnant.

Out of: Produced from the mare.

Pedigree: A record of ancestry.

Pony: A horse under 14.2 hands.

Pregnancy Testing: Examining the mare to determine if she has conceived.

Protein: The total nitrogenous material in vegetable or animal substance.

INFORMATION SHEET

CLASSIFICATION OF HORSES

ACCORDING TO TYPE AND USE

A. Riding Horses:

  1. Saddle (three gaited, five gaited)
  2. Walking
  3. Stock
  4. Polo
  5. Hunters and Jumpers
  6. Ponies

B. Race Horses:

  1. Running (thoroughbred, quarter, etc.)
  2. Harness (trotters and pacers)

C. Driving Horses:

  1. Heavy Harness
  2. Fine Harness
  3. Roadsters
  4. Ponies (heavy and light harness)

D. Work Horses:

  1. Draft
  2. Wagon
  3. Exhibition

JOB SHEET

CLEANING A HORSE'S HOOF

I. Equipment and materials:

- A. Apron
- B. Lead rope
- C. Hoof spike
- D. Pedicure file

II. Procedure

- A. Near forefoot
  1. Slide left hand down cannon to fetlock
  2. Lean left shoulder against horse
  3. Pick up foot when horse shifts weight
  4. Place horse's foot between your legs
  5. Clean hoof, heel to toe
- B. Near hind foot
  1. Stand foreward of the hindquarter
  2. Stroke right hand from point of hip down the hip to middle cannon
  3. Place left hand on hip, pressuring horse to shift weight
  4. Move to rear, keeping your leg straight
  5. Swing left leg over the horse's fetlock
  6. Hold hoof with left hand
  7. Clean hoof, heel to toe with your right hand

III. Observations:

STUDENT JOB SHEET

BREEDS OF LIGHT HORSES AND THEIR CHARACTERISTICS

Breeds & Address of Breed Assoc.	Place of Origin	Color	Other Distinguishing Characteristics	Primary Uses	Disqualifications

STUDENT JOB SHEET

SADDLING A HORSE

(Reference VAS Slide Set #151)

I. Equipment:

1. Saddle
2. Lead rope
3. Halter

II. Procedures:

1. Halter horse
2. Tie horse
3. Approach horse from shoulder on left side
4. Smooth hair over back
5. With one hand on pommel and the other on cantle, place saddle on withers
6. Slide saddle back to correct position
7. Make sure sweat flaps are not curled
8. Straighten girth
9. Slide girth through martingale loop and buckle up loosely
10. Lead horse around
11. Retighten girth

III. Observations:

STUDENT JOB SHEET

BRIDLING A HORSE

I. Equipment:

Horse
Bridle

II. Procedure:

Bridle in position

1. Place nose between check piece
2. Position crown piece in front of ear
3. Dangle bit against teeth

Open mouth

Bridle on

1. Bit in mouth
2. Crown piece over ear

Throat latch buckled

III. Observations:

STUDENT JOB SHEET

MOUNTING A HORSE

I. Equipment or tools:

Horse

Saddle

Bridle

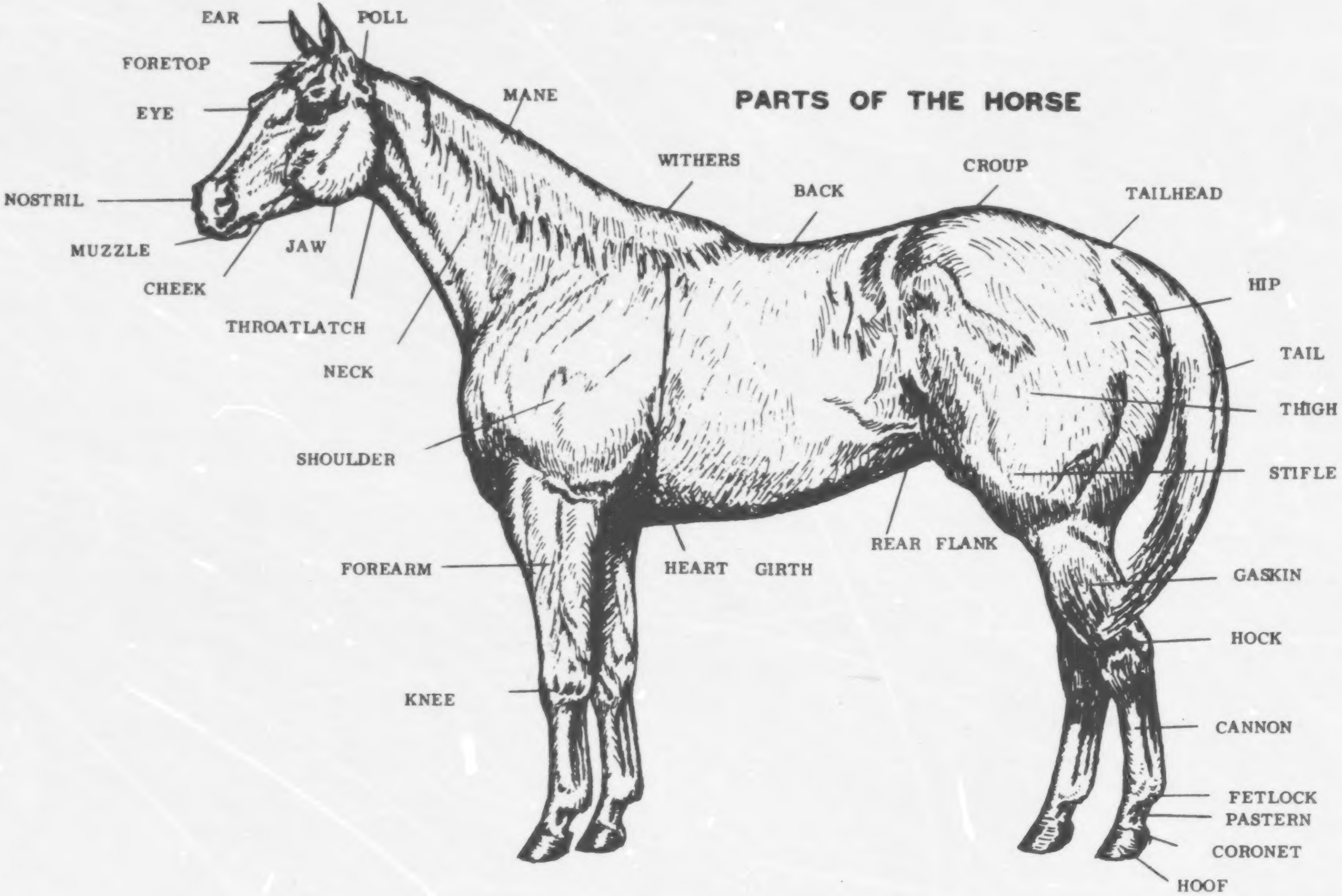
Corral

II. Procedure:

1. Mount from near or left side
2. Gather reins in left hand
3. Steady stirrup with right hand
4. Pause momentarily in standing position
5. Swing right leg over horse's back
6. Ease down into the saddle
7. Secure right stirrup without looking down
8. Sit easily with head up and heels down

III. Observations:

PARTS OF THE HORSE


EAR
POLL
FORETOP
EYE
MANE
NOSTRIL
MUZZLE
JAW
CHEEK
THROATLATCH
NECK
WITHERS
BACK
CROUP
TAILHEAD
HIP
TAIL
THIGH
SHOULDER
STIFLE
REAR FLANK
FOREARM
HEART GIRTH
GASKIN
HOCK
KNEE
CANNON
FETLOCK
PASTERN
CORONET
HOOF

M-1-1-3-17

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign (Horses 1)
From Lesson Plans for V[illegible] Instructors, Texas A & M University

PARTS OF THE HORSE*

Knowing the names of the parts of a horse is one of the first necessities of horse selection or judging.

*From "Lesson Plans for Voc. Agr. Instructors" by Vocational Agriculture Services, College Station, Texas.

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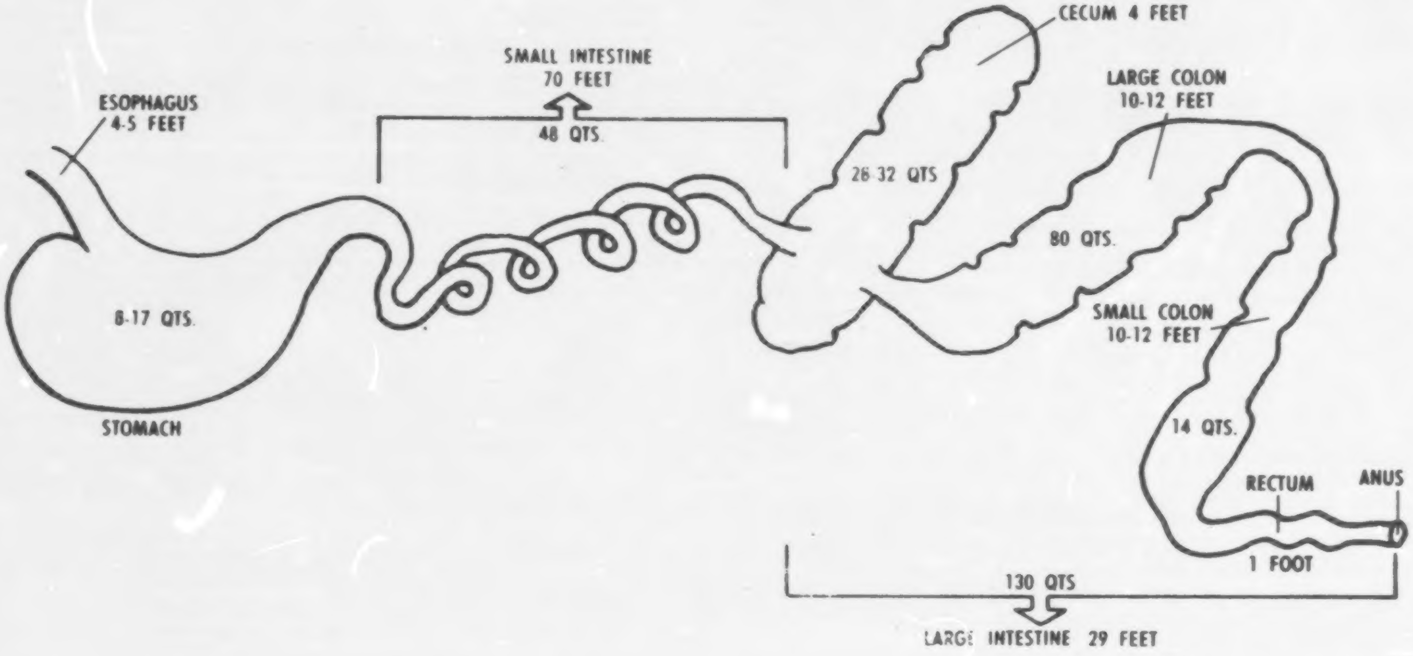
DIGESTIVE SYSTEM OF THE HORSE


CECUM 4 FEET
SMALL INTESTINE
70 FEET
48 QTS.
ESOPHAGUS
4-5 FEET
26-32 QTS.
LARGE COLON
10-12 FEET
80 QTS.
8-17 QTS.
SMALL COLON
10-12 FEET
STOMACH
14 QTS.
RECTUM
ANUS
1 FOOT
130 QTS
LARGE INTESTINE 29 FEET

M-I-I-3-19

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign (Horses 8)
From Horse Science, Federal Extension Service

THE DIGESTIVE SYSTEM OF THE HORSE

The digestive system of the horse is different from that of the other farm animals. Although the horse has a single compartment stomach like man, the pig, and the dog, the horse can utilize roughages like the cow which is a ruminant. This is possible because the horse has a special type of intestine.

The digestive system is composed of the alimentary canal and its accessory organs. The alimentary canal is a hollow tube which extends from the mouth to the anus and has the following parts: mouth, pharynx, esophagus, stomach, small intestine, large intestine, and anus. Teeth, tongue, salivary glands, liver, and pancreas are the accessory organs.

Digestion is the process of preparation of food for absorption from the alimentary canal into the blood stream and elimination of the unabsorbed residue from the body. The digestive process includes the combined effects of mechanical, secretory chemical, and microbiological factors. The mechanical factors are chewing (mastication), swallowing (deglutition), movements of stomach and intestines, and elimination of residue (defecation). The digestive glands secrete digestive juices. Bacteria and possibly protozoa are the microbial influences. Understanding the structure (anatomy) and function (physiology) of the unusual digestive system of your horse helps you appreciate proper feeding of your horse.

From "Horse Science," Federal Extension Service, Washington, D. C.

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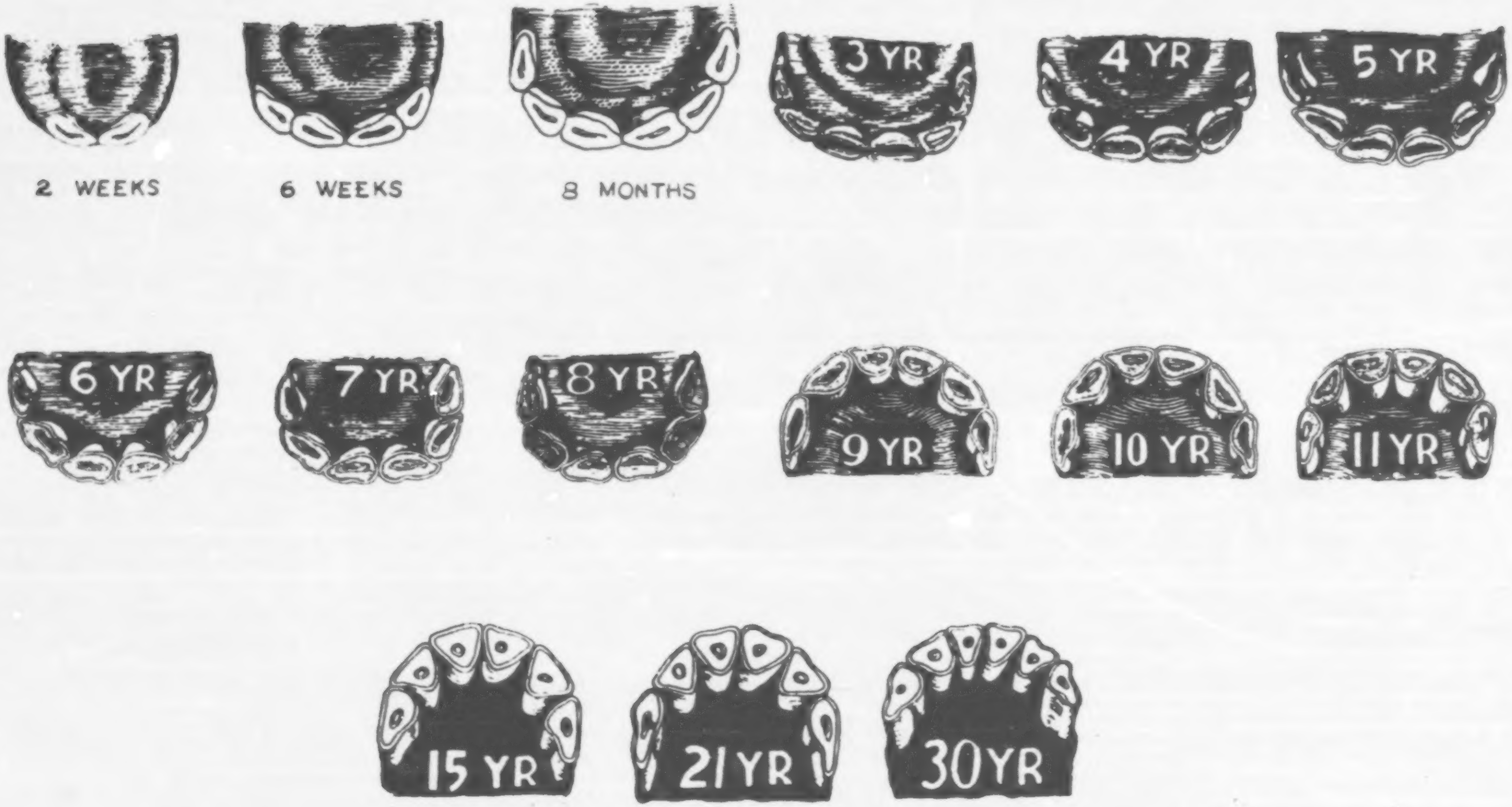
HORSE'S AGE BY ITS TEETH


2 WEEKS
6 WEEKS
8 MONTHS
3 YR
4 YR
5 YR
6 YR
7 YR
8 YR
9 YR
10 YR
11 YR
15 YR
21 YR
30 YR

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign (Horses 11)
From Horsemanship Manual, Appaloosa Horse Club, Inc.

HORSE'S AGE BY ITS TEETH

To tell the age of any horse,
Inspect the lower jaw of course.

Two middle nippers you'll behold
Before the colt is two weeks old.

Before six weeks, two more will come;
Eight months the corners cut the gum.

At two the middle nippers drop;
At three the second pair can't stop

At four years old the side pair shows;
At five a full mouth he grows.

The side two pairs at seven years,
And eight will find the corners clear.

The middle nipper, upper jaw,
At nine the black spots will withdraw.

At ten years old the sides are light;
Eleven finds the corners white.

As time goes on the horsemen know
The oval teeth three sided grow.

They longer get, project before,
'Til twenty when we know no more.

--Author unknown

From "Horsemanship Manual," Appaloosa Horse Club, Inc., Moscow, Idaho.

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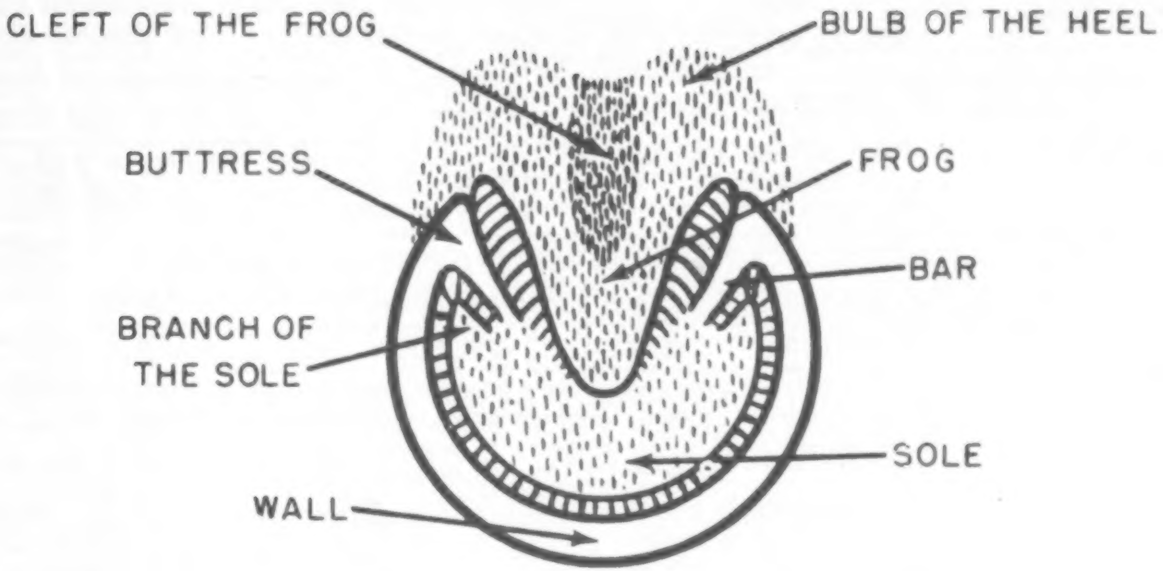
PARTS OF THE FOOT


CLEFT OF THE FROG
BULB OF THE HEEL
BUTTRESS
FROG
BAR
BRANCH OF THE SOLE
SOLE
WALL

M-1-1-3-23

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign (Horses 14)
From Idaho Ext. Bul. 492, Horse Sense and Safety

PARTS OF THE FOOT

From Idaho Ext. Bul. 492, "Horse Sense and Safety," Moscow, Idaho.

VOCATIONAL AGRICULTURE SERVICE
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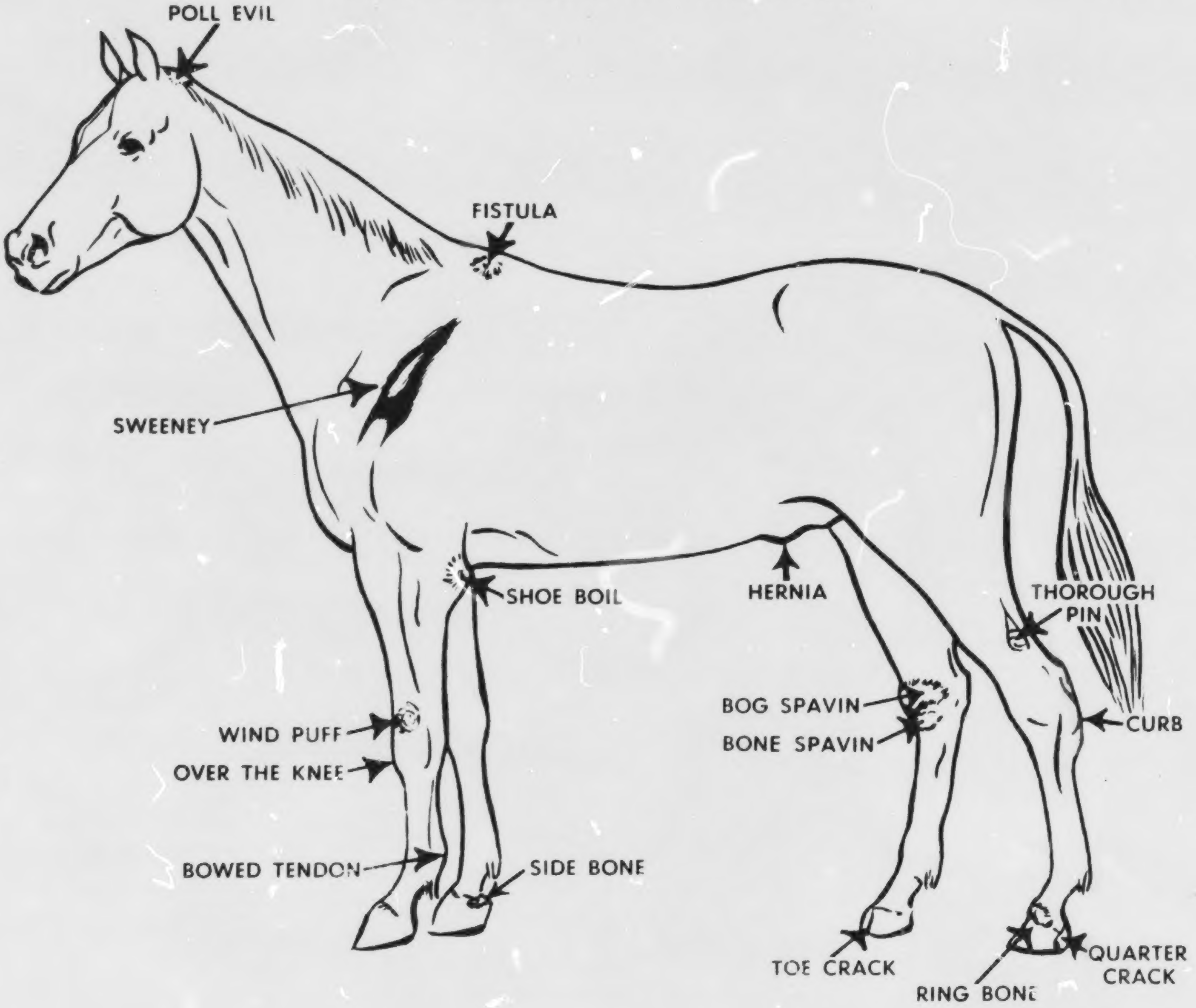
UNSOUNDNESSES OF THE HORSE


POLL EVIL
FISTULA
SWEENEY
SHOE BOIL
HERNIA
THOROUGH PIN
BOG SPAVIN
BONE SPAVIN
CURB
WIND PUFF
OVER THE KNEE
BOWED TENDON
SIDE BONE
TOE CRACK
RING BONE
QUARTER CRACK

M-1-1-3-25

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign (Horses 22)
From Horse Science, Federal Extension Service

UNSOUNDNESSES OF THE HORSE

The following unsoundnesses and blemishes are identified: U-unsoundness, B-blemish.

Head

1. Cataract (U)--cloudy or opaque appearance of the eye.
2. Defective eyes (U)--impaired vision or blindness.
3. Poll evil (U)--inflamed swelling of poll between ears.
4. Roman nose--faulty conformation.
5. Parrot mouth (U)--lower jaw is shorter than upper jaw.
6. Undershot jaw (U)--upper jaw is shorter than lower jaw.

Neck

1. Ewe-neck--faulty conformation.

Withers and Shoulders

1. Fistula of withers (U or B)--inflamed swelling of withers.
2. Sweeny (U)--atrophy or decrease in size of a single muscle or group of muscles, usually found in shoulder or hip.

Front Legs

1. Shoe boil or capped elbow (B)--soft, flabby swelling at the point of elbow.
2. Knee--sprung or buck knee--over on the knees. Faulty conformation.
3. Calf-kneed--back at the knees. Faulty conformation.
4. Splint (B)--capsule enlargement usually found inside upper part of front cannon.
5. Wind puff (U)--puffy swellings occurring either side of tendons above fetlock or knee.
6. Bowed tendons (U)--enlarged, stretched flexor tendons behind the cannon bones.
7. Ringbone (U)--bony growth on either or both sides of pastern.
8. Sidebone (U)--bony growth above and toward the rear quarter of hoofhead.
9. Quittor (U)--fistula of the hoofhead.
10. Quarter or sand crack (B)--vertical split in the wall of the hoof.
11. Navicular disease (U)--inflamation of small navicular bone usually inside front foot.
12. Founder (U)--turning up of hoof and rough, deep rings in hoof wall caused by over feeding, severe concussion or disease and abnormal management.
13. Contracted feet (B)--abnormal contraction of heel.
14. Thrush (B)--disease of the frog.

Body

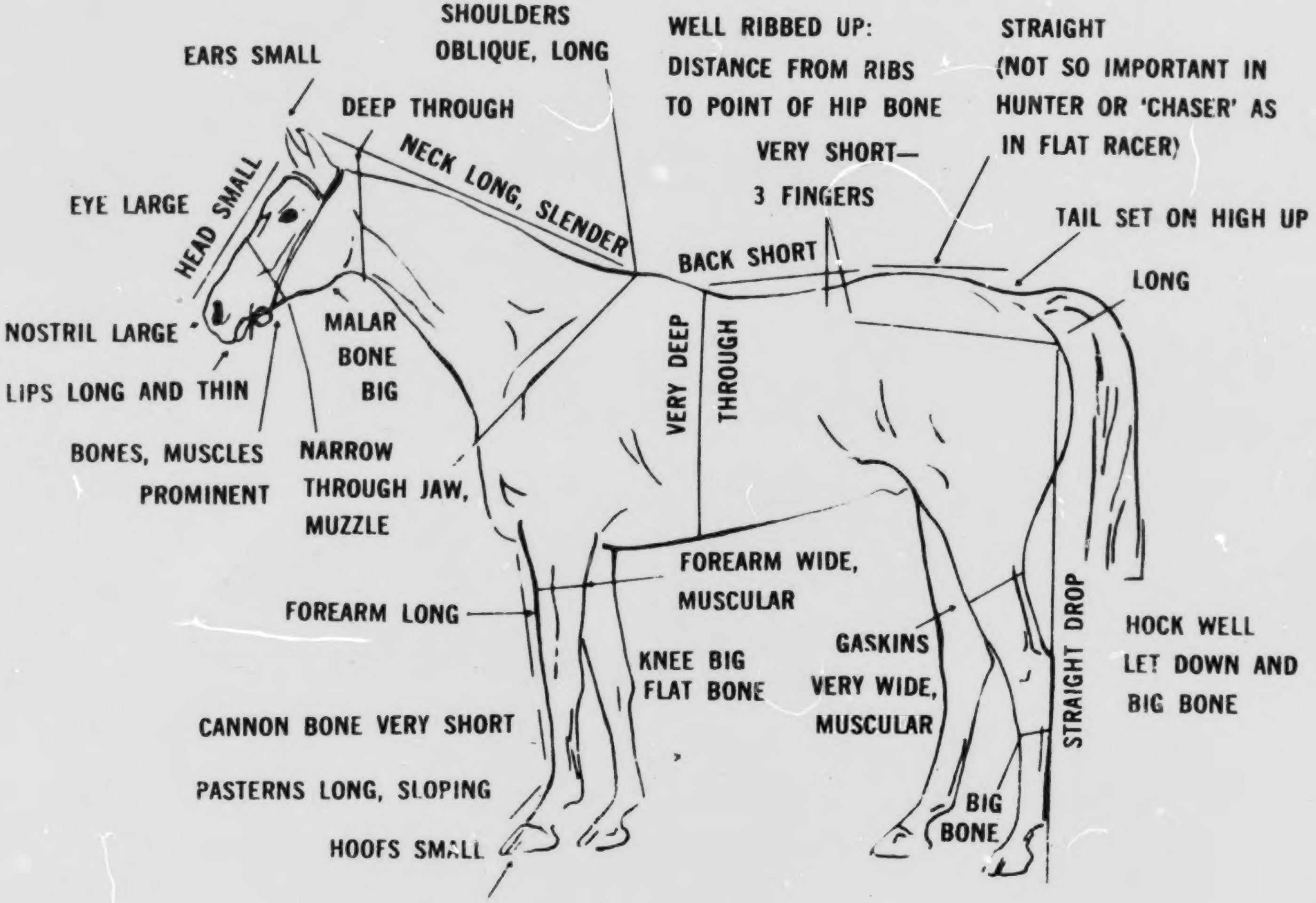
1. Heaves (U)--difficult breathing, lung damage.
2. Roaring (U)--difficult breathing due to obstruction usually in larynx.
3. Rupture (U)--protrusion of internal organs through the wall (hernia) of the body. Umbilical or scrotal areas most common.
4. Sway back--faulty conformation.
5. Hipdown (U)--fracture of prominence of hip and falling away.

Rear Limbs

1. Stifled (U)--displaced patella of stifle joint.
2. Stringhalt (U)--nervous disorder characterized by excessive jerking of the hind leg.
3. Thoroughpin (U)--puffy swelling which appears on upper part of hock and in front of the large tendon.
4. Capped hock (B or U)—enlargement on point of hock. Depends on stage of development.
5. Bog spavin (U)--meaty, soft swelling occurring on inner front part of hock.
6. Bone spavin or jack spavin (U)--bony growth usually found on inside lower point of hock.
7. Curb (U)--hard swelling on back surface of rear cannon about four inches below point of hock.
8. Cocked ankle (U)--usually in hind feet. Horse stands bent forward, due to contracted tendons.
9. Blood spavin (B)--swelling of vein usually below seat of bog spavin.

From "Horse Science," Federal Extension Service, Washington, D. C.

DESIRED HORSE TRAITS


SHOULDERS OBLIQUE, LONG
EARS SMALL
DEEP THROUGH
WELL RIBBED UP: DISTANCE FROM RIBS TO POINT OF HIP BONE VERY SHORT— 3 FINGERS
STRAIGHT (NOT SO IMPORTANT IN HUNTER OR 'CHASER' AS IN FLAT RACER)
NECK LONG, SLENDER
EYE LARGE
HEAD SMALL
TAIL SET ON HIGH UP
BACK SHORT
LONG
NOSTRIL LARGE
MALAR BONE BIG
VERY DEEP
THROUGH
LIPS LONG AND THIN
BONES, MUSCLES PROMINENT
NARROW THROUGH JAW, MUZZLE
FOREARM WIDE, MUSCULAR
FOREARM LONG
GASKINS VERY WIDE, MUSCULAR
KNEE BIG FLAT BONE
STRAIGHT DROP
HOCK WELL LET DOWN AND BIG BONE
CANNON BONE VERY SHORT
PASTERNS LONG, SLOPING
BIG BONE
HOOFS SMALL

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign (Horses 23)
From Minn. Ext. Bul. 351, Selecting Your Horse

DESIRED HORSE TRAITS

From Minn. Ext. Bul. 351, "Selecting Your Horse," St. Paul, Minnesota.

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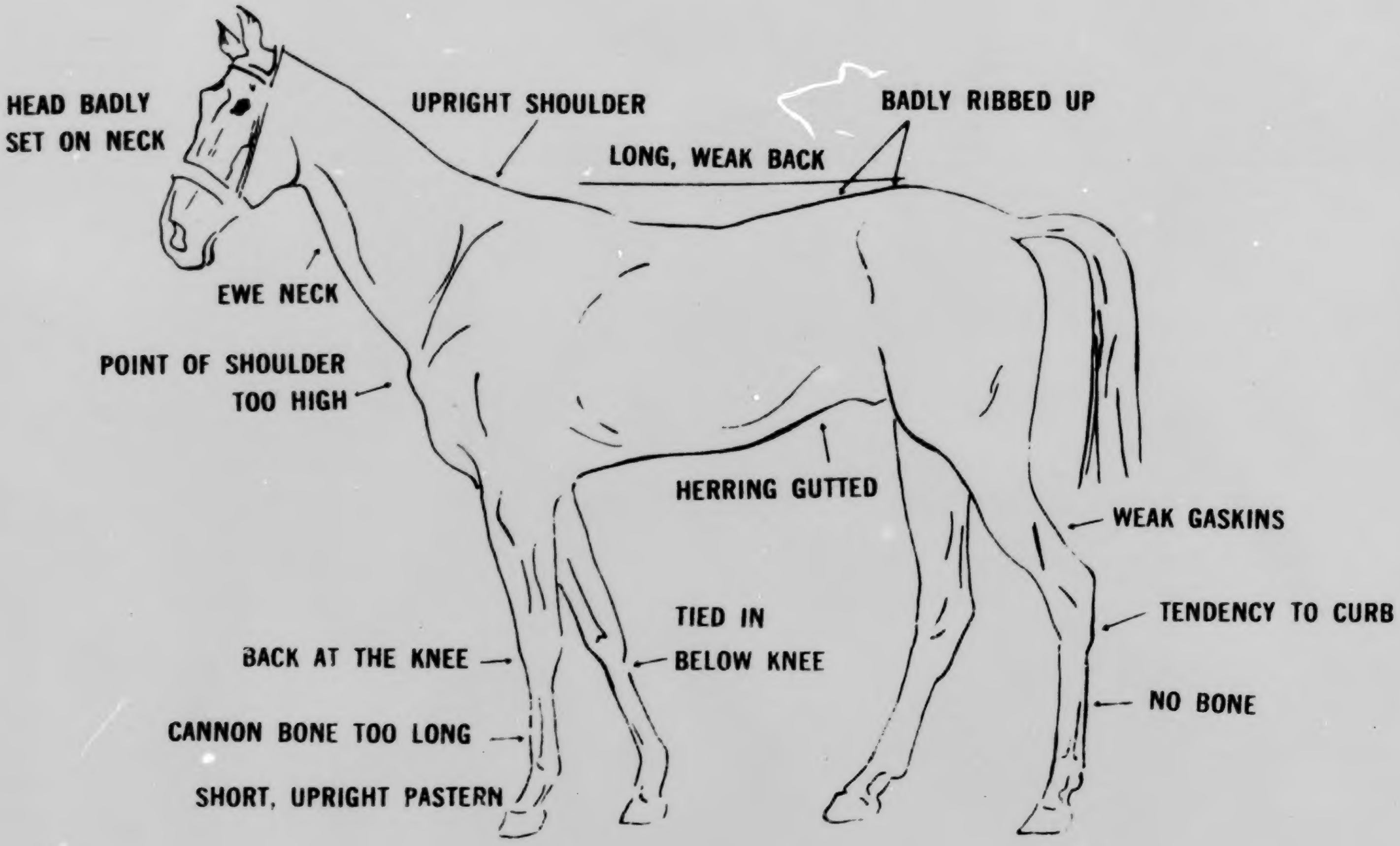
M-1-1-3-28

A HORSE WITH MANY FAULTS


HEAD BADLY SET ON NECK
UPRIGHT SHOULDER
BADLY RIBBED UP
LONG, WEAK BACK
EWE NECK
POINT OF SHOULDER TOO HIGH
HERRING GUTTED
WEAK GASKINS
TIED IN BELOW KNEE
TENDENCY TO CURB
BACK AT THE KNEE
NO BONE
CANNON BONE TOO LONG
SHORT, UPRIGHT PASTERN

Vocational Agriculture Service · College of Agriculture · University of Illinois at Urbana-Champaign (Horses 24)
From Minn. Ext. Bul. 351, Selecting Your Horse

A HORSE WITH MANY FAULTS

From Minn. Ext. Bul. 351, "Selecting Your Horse," St. Paul, Minnesota.

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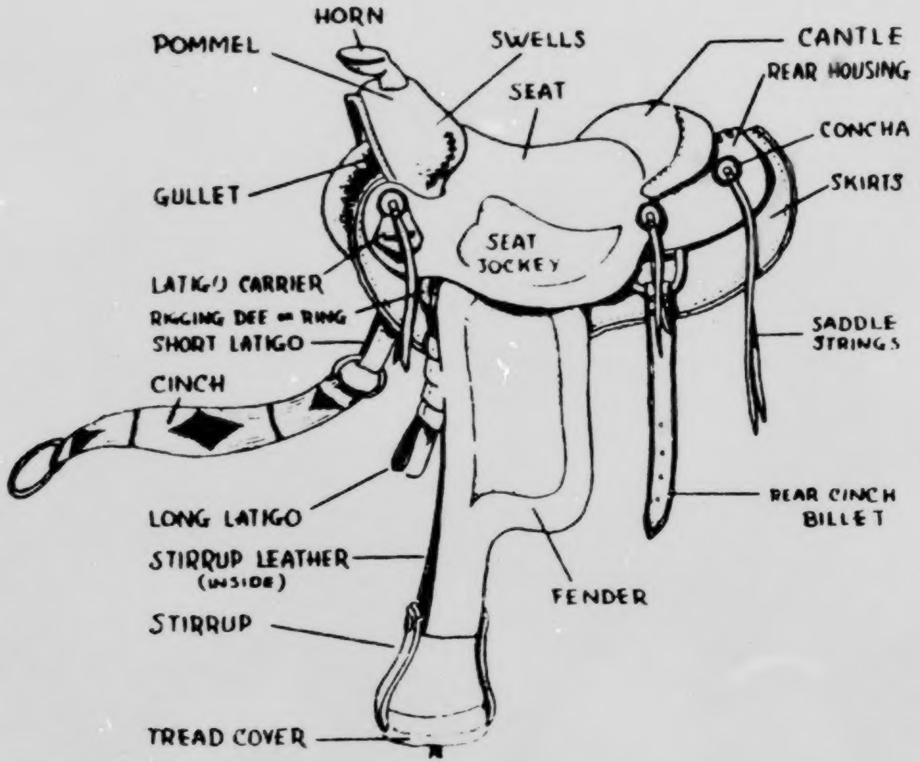
M-1-1-3-30

PARTS OF THE STOCK SADDLE


HORN
POMMEL
SWELLS
SEAT
CANTLE
REAR HOUSING
CONCHA
SKIRTS
GULLET
SEAT JOCKEY
LATIGO CARRIER
RIGGING DEE — RING
SHORT LATIGO
SADDLE STRINGS
CINCH
REAR CINCH BILLET
LONG LATIGO
STIRRUP LEATHER (INSIDE)
FENDER
STIRRUP
TREAD COVER

M-I-1-3-31

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign . (Horses 29)
From Horsemanship Manual, Appaloosa Horse Club, Inc.

PARTS OF THE STOCK SADDLE

From "Horsemanship Manual," Appaloosa Horse Club, Inc., Moscow, Idaho.

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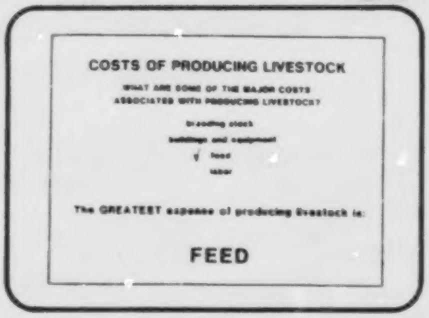
300

M-I-1-3-32

ANIMAL NUTRITION



COSTS OF PRODUCING LIVESTOCK

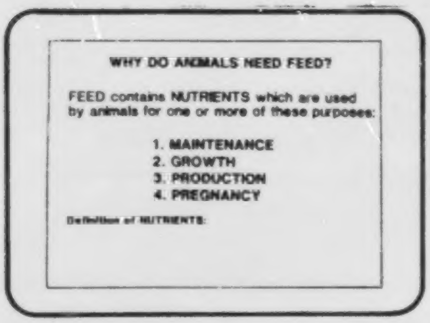
WHAT ARE SOME OF THE MAJOR COSTS
ASSOCIATED WITH PRODUCING LIVESTOCK?

breeding stock
buildings and equipment
✓ feed
labor

The GREATEST expense of producing livestock is:

FEED

2. The costs associated with the production of livestock include: purchase price of breeding or feeder stock, buildings, equipment, land, feed, labor, interest on capital investment, etc. The largest of these expenses is feed. It may range from 60 to 80% of the total production costs.



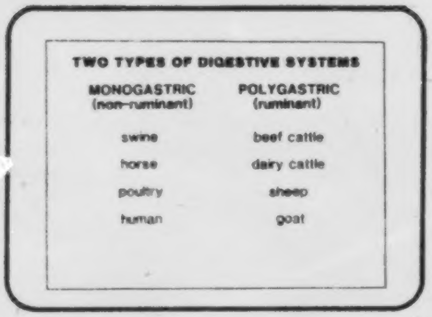
WHY DO ANIMALS NEED FEED?

FEED contains NUTRIENTS which are used by animals for one or more of these purposes:

1. MAINTENANCE
2. GROWTH
3. PRODUCTION
4. PREGNANCY

Definition of NUTRIENTS:

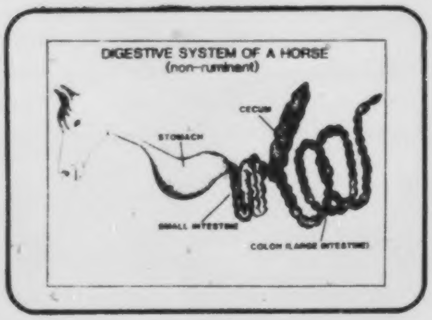
3. Animals must have the **nutrients** provided by feed ingredients in order to survive. These nutrients are used for **maintenance, growth, production, and pregnancy**. Nutrients may be defined as: "The chemical substances found in feed materials that are necessary for proper body functioning."



TWO TYPES OF DIGESTIVE SYSTEMS

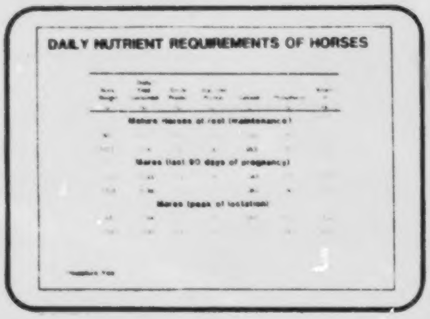
MONOGASTRIC (non-ruminant)	POLYGASTRIC (ruminant)
swine	beef cattle
horse	dairy cattle
poultry	sheep
human	goat

8. There are two types of digestive systems found in common farm animals. Swine, horses, and poultry are known as non-ruminants or monogastric animals because they have one stomach. Cattle, sheep, and goats are known as ruminants or polygastric animals because they have four sections to their stomach.



DIGESTIVE SYSTEM OF A HORSE
(non-ruminant)

11. Note only one section to the stomach, but a large cecum. The cecum in the horse (also in the rabbit) has many functions similar to the rumen in ruminants. It allows horses to eat large quantities of forages.



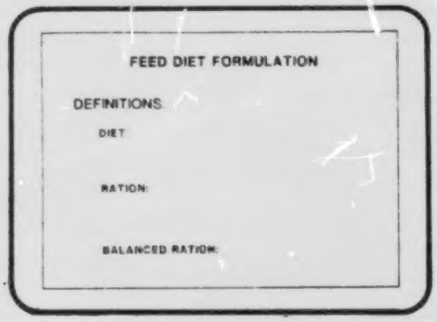
DAILY NUTRIENT REQUIREMENTS OF HORSES

Mature horses at rest (maintenance)

Mares (last 90 days of pregnancy)

Mares (peak of lactation)

41. Daily nutrient requirements for three classifications of horses are shown.



FEED DIET FORMULATION

DEFINITIONS

DIET

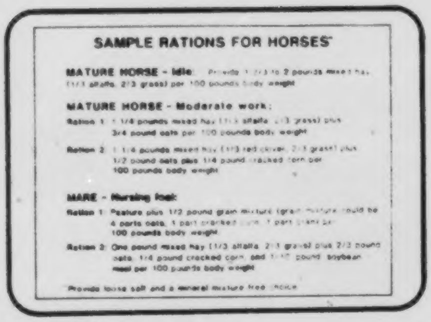
RATION:

BALANCED RATION:

53. **Diet**: The feed ingredient or mixture of ingredients, including water which is consumed by the animal.

Ration: The amount of feed supplied to an animal in a 24 hour period.

Balanced Ration: A ration that provides an animal the proper amounts and proportions of all required nutrients for a 24 hour period.



SAMPLE RATIONS FOR HORSES*

MATURE HORSE – Idle: Provide 1 2/3 to 2 pounds mixed hay (1/3 alfalfa, 2/3 grass) per 100 pounds body weight

MATURE HORSE – Moderate work:

Ration 1: 1 1/4 pounds mixed hay (1/3 alfalfa, 2/3 grass) plus 3/4 pound oats per 100 pounds body weight

Ration 2: 1 1/4 pounds mixed hay (1/3 red clover, 2/3 grass) plus 1/2 pound oats plus 1/4 pound cracked corn per 100 pounds body weight

MARE – Nursing foal:

Ration 1: Pasture plus 1/2 pound grain mixture (grain mixture could be 4 parts oats, 1 part cracked corn, 1 part bran) per 100 pounds body weight

Ration 2: One pound mixed hay (1/3 alfalfa, 2/3 grass) plus 2/3 pound oats, 1/4 pound cracked corn, and 1/10 pound soybean meal per 100 pounds body weight

*Provide loose salt and a mineral mixture free choice

71. Sample rations for horses.

SAMPLE TEST QUESTIONS AND TEACHER'S KEY

True (+) - FALSE (0)

_0_ 1. A stock horse is a large, clean cut horse bred for cross-country riding and jumping.

_+_ 2. Walking horses were originally developed for plantation riding.

_0_ 3. The stifle joint is on the shoulder between the shoulder blade and the forearm.

_+_ 4. The withers are the top points of the two shoulder blades.

_+_ 5. Black points on a horse are black mane, tail, feet and legs.

_+_ 6. The smooth mouth period of a horse is approximately 11 years of age.

_+_ 7. A horse requires about 1 1/3 ounces of salt daily.

_0_ 8. If a horse is hot, it will not hurt to let it drink all of the water that it wants.

_+_ 9. Thrush is a disease of the frog of the foot, caused by poor sanitation.

_+_ 10. Two tracking is the movement in which a horse moves forward in a diagonal direction with its front feet and back feet making two sets of parallel tracks.

MULTIPLE CHOICE (Mark appropriate choice of A, B, C, or D)

_B_ 1. A popular saddle breed(s) is:

A. Welsh
B. Quarter Horse
C. Percheron
D. Shetland

_E_ 2. Parts of a hindleg of a horse are:

A. Stifle
B. Knee
C. Hock
D. All three
E. A and C only

C. 3. The poll is on:

A. Hind leg
B. Front leg
C. Head
D. Rump

B 4. Roan color:

A. Has black, white, and yellow hairs intermingled.
B. Has red, white, ad yellow hairs intermingled.
C. Mouse colors to golden dun.
D. Varies from light to dark bay.

A 5. Horses under five years of age may have their age judged by:

A. Eruption of the incisors
B. Wear of the incisors
C. Shape of the biting surface
D. Angle at which the incisors meet

C 6. Minerals most generally lacking in a horse's ration are:

A. Steamed bonemeal and dicalcium phosphate
B. Dicalcium phosphate and iron
C. Calcium and phosphorus
D. Calcium and vitamin C

B 7. Total digestible nutrients are the:

A. Digestible proteins
B. Building blocks for the animal body
C. Concentrates
D. Roughages

D 8. A box stall for mares for foaling should be at least:

A. 4 feet by 8 feet
B. 5 feet by 12 feet
C. 8 feet by 10 feet
D. 10 feet by 10 feet

C 9. A cinch is a part of the:

A. Bridle
B. Hackamore
C. Saddle
D. Reins

C 10. In the show ring, it is ok to let your horse relax:

A. After you enter the ring before judging starts
B. As you enter the ring
C. When the judge is studying the other end of the class
D. As you leave the ring

1. Match the terms on the right to the correct definition.

___ a. Braided rawhide or rope noseband of a bosal hackamore; knotted under the horse's jaw

___ b. Act of getting on a horse

___ c. Membranes of the bars of the mouth where the bit rests have become toughened and and nerves deadened because of pressure of the bit

___ d. Part of the reins passing between thumb and fingers and out the top of the hand

___ e. Horse that pulls back on the halter rope

___ f. Term that describes the horse's playing with the bit

___ g. Girth of a western saddle

___ h. Bit with prongs extending at the nose to tip horse's head up

___ i. Cleaning with a curry comb

1. Bight of the reins
2. Bosal
3. Champing
4. Cinch
5. Crab bit
6. Curry
7. Halter puller
8. Hard mouthed
9. Mounting

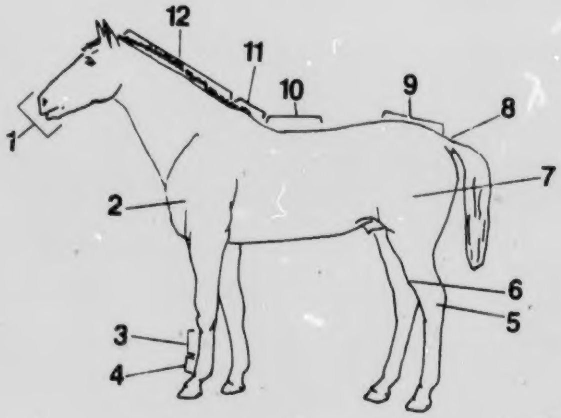
MATCHING (Match the correct phrases with the qualities listed.)

E 1. Coarse
C 2. Colt
I 3. Stylish
M 4. Quality
G 5. Paunchy
A 6. Mare
K 7. Bloom
B 8. Pudgy
L 9. Soundness
H 10. Filly

A. A mature female horse over 5 years old
B. Dumpy, short, and thickset
C. A young male horse up to 5 years old
D. Body shape or form
E. Rough harsh appearance. Lacking refinement.
F. Healthy, active, and vigorous
G. Description of an animal with too much belly
H. A young female horse under 5 years of age
I. Having a pleasing, graceful, alert, general appearance
J. A young horse of either sex up to a yearling
K. Hair that is clean, fluffy, with healthy, fine texture
L. Freedom from any abnormal structure or function which interferes with the usefulness of the individual
M. Fineness of texture. Freedom from coarseness.

1. Match the correct anatomy on the right to the correct name.

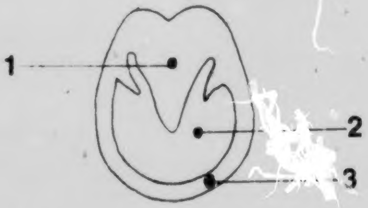
___ a. Muzzle
___ b. Cannon
___ c. Mane
___ d. Back
___ e. Shoulder
___ f. Croup
___ g. Fetlock joint
___ h. Hock
___ i. Thigh
___ j. Gaskin
___ k. Dock
___ l. Withers



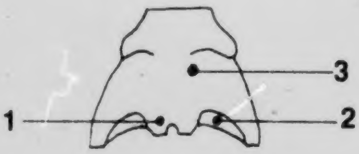
2. Match the correct anatomy on the right to the correct name.

___ a. Frog
___ b. Wall
___ c. Sole

1



2



Identification

1. Identify the parts of the Western saddle as shown in the picture below.

   a.

   b.

   c.

   d.

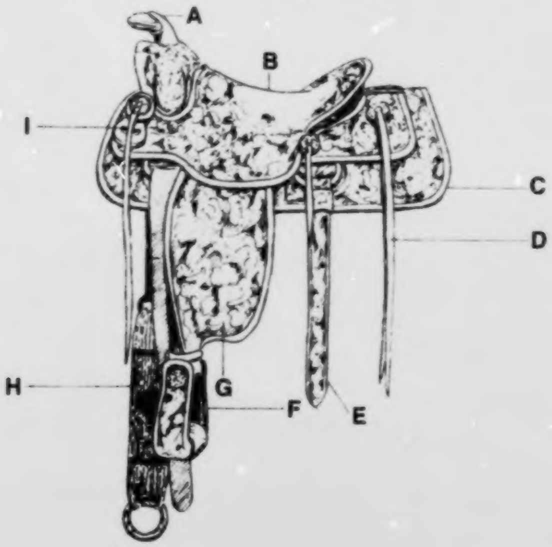
   e.

   f.

   g.

   h.

   i.



2. Identify the parts of the bridle as shown in the picture below.

   a.

   b.

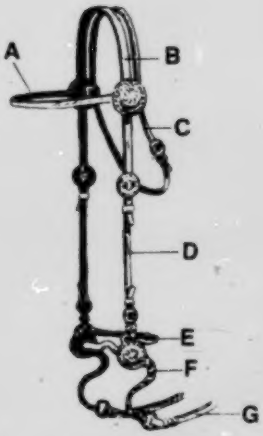
   c.

   d.

   e.

   f.

   g.



COMPLETION (Write the appropriate word or words to complete the statements.)

1. A breed is a group of animals which was started from a common origin.

2. Ponies are small horses under 14.2 hands in height at maturity.

3. The angles of the front pasterns are related to the slope of the shoulders.

4. Blemishes are imperfections found on a horse that do not affect its service-ability.

5. Unsoundnesses are imperfections that affect the serviceability of a horse.

6. A mature male horse has 40 teeth. A mature mare has 36 teeth.

7. The secret of all training methods is to get the horse to do what you want done without fighting back.

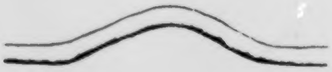
8. Many horsemen use a lunge line for training and conditioning horses.

9. Every horseman is a rider but not every rider is a horseman.

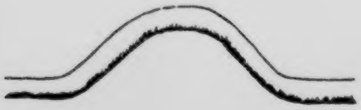
10. Always speak to a horse before approaching or touching it. A horse may jump or kick when startled.

5. Identify the types of mouthpieces below.

a. ______________________



b. ______________________



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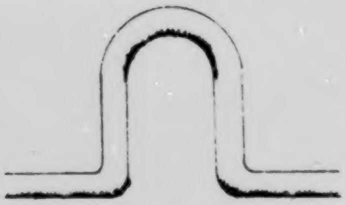
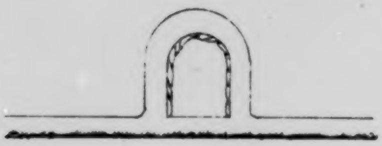


d. ______________________

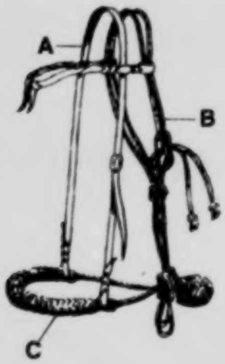


3. Identify the three parts of the hackmore shown below.

a.

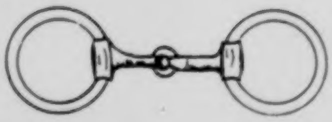
b.

c.



4. Identif the bits shown below.

a. ______________________



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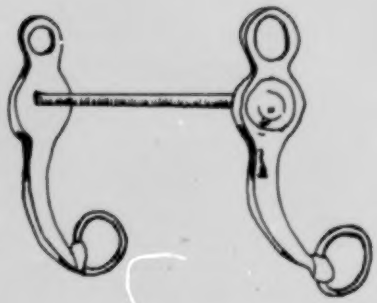
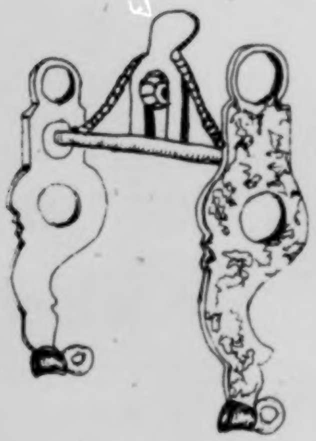


c. ______________________



List and/or Discuss

1. List six methods of marking or registering horses for identification.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

   f. ______________________________

2. List three reasons for registering eligible horses.

   a.

   b.

   c.

3. List two reasons for castrating horses.

   a.

   b.

4. Why should the colt be halter broken at a young age?

5. Explain how you would catch and halter a young foal.

6. What two knots are required when tieing a foal with a belly rope to a tree or post?

   a.

   b.

7. List two reasons for grooming horses.

   a.

   b.

ESSAY QUESTIONS

1. Explain in detail the care that should be given to the horse's feet.

(See pages 16 & 17)
in
VAS Unit # 1047

2. Decribe the major factors or points to keep in mind while handling and caring for the newborn foal.

3. How should you bridle and saddle a horse in a low-ceiling stall?

(See pages 25 & 26)
in
VAS Unit #1047

8. List four articles of equipment needed to groom a horse properly.

   a.

   b.

   c.

   d.

9. List two reasons for clipping horses.

   a.

   b.

10. List three conditions under which horses should be shod.

    a.

    b.

    c.

11. List four tools used by the farrier in shoeing horses.

    a.

    b.

    c.

    d.

12. Why would a farrier use hot shoes rather than cold on a horse?

UNIT J: Soil Science and Conservation of Natural Resources

PROBLEM AREAS:

1. Pasteurizing and preparing a growing media for the greenhouse
2. Collecting soil samples from the greenhouse, garden and lawn and applying sample test results
3. Identifying soil amendments and their functions

UNIT J: SOIL SCIENCE AND CONSERVATION OF NATURAL RESOURCES

PROBLEM AREA: PASTEURIZING AND PREPARING A GROWING MEDIA FOR THE GREEN HOUSE

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with freshman or beginning students enrolled in horticultural or agricultural occupations program. The recommended time for teaching this problem area is during the fall semester prior to the planting of any plants. The estimated time for teach this problem area is 7 to 10 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the assumption that the student would prepare a growing media for greenhouse crops. Several different growing media are required for growing different crops in the school greenhouse or growing plants in the home. The information about soil preparation might also be incorporated with related units of instruction.

Instructors are encouraged to conduct a local search to locate other supplementary materials for use with this problem area for reference or modification as they adapt this material to their local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 63777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide, and sample test questions were developed by James Ethridge. Transparency masters and the transparency discussion guide were prepared by the Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Polot Test Teachers.

Laboratory Exercises on "Steaming Soil", "Mixing Fertilizer with the Soil", Mixing Soil on the Floor Using Wheelbarrow to Measure Volume", Mixing Soil With a Concrete Mixer", "Mixing Soil on a Potting Bench", "Soil Preparation For Seeding or Sodding," were adopted from materials written by Dana E. Wallace and Taylor Byrd, Department of Agricultural Education, Pennsylvania State University. Information sheets were developed by Vaughn-Jacklin Corporation and reprinted with their permission.

TEACHER'S GUIDE

I. Unit: Soil science and conservation of natural resources

II. Problem area: Pasteurizing and Preparing Growing Media For the Greenhouse.

III. Objectives: At the close of this problem area students will be able to

1. Define terms relating to soil sterilants.
2. Name the methods of pasteurizing soil.
3. Demonstrate knowledge of how, when, and why soils are pasteurized.
4. State the length of time and temperature for steaming soils.
5. Identify problems that can occur when steaming soils and their solutions.
6. Demonstrate familiarity with chemicals, soil fumigants, and how to handle them.
7. Name the characteristics of a good soil medium.
8. Name soilless, artificial medium mixtures.
9. Name the advantages and disadvantages of soilless mixes.
10. Mix suggested growing media for specific crops.

IV. Suggested interest approaches:

1. Take class on field trip to observe the mixing of various growing media.
2. Have samples of various soil mixes on display in the classroom and discuss how they are alike and different.
3. Promote interest and discussion by asking the following questions: "How many of you have worked with growing plants?" "How did you prepare the growing media?" "Is field soil satisfactory for potting plants?" "What should be done to make the soil a better growing media?" "Will the same soil mixture be satisfactory for all horticulture plants?"
4. Plant a flat of seeds in "dirty" soil and plant a flat of seed in "clean" soil. Compare the results.
5. Divide the nursery or greenhouse into sections. Hold a sanitation problem hunt.

6. Ask students to describe their experiences in pasteurizing soils.

7. Take a field trip to a greenhouse or nursery to observe soil being pasteurized.

V. Anticipated problems and concerns of students:

1. What is the difference between pasteurization and sterilization of soils?

2. What are some methods of pasteurization?

3. What cost is involved in each method?

4. What are the advantages and disadvantages of each method?

5. What special equipment is needed for pasteurization?

6. What plants are sensitive to the different methods of pasteurization?

7. Can soil be "overpasteurized?"

8. Why is it necessary to pasteurize soils?

9. What kind of mixes are available?

10. Why do growers mix their own soil?

11. What is the cost of mixing your own growing media?

12. How do you determine the proper soil mix for a specific crop?

13. How do you mix a proper growing media?

VI. Suggested learning activities and experiences:

1. Have students read VAS Unit 5024 and record tentative answers to the problems and concerns identified by the class and instructor.

2. Discuss losses due to weeds and diseases within the nursery or greenhouse. Consider time and money involved in raising plants that are lost to poor sanitation practices.

3. Distribute and complete laboratory exercises.

4. Present and discuss transparencies.

5. Review terms relating to soil pasteurization.

6. Discuss pasteurization and sterilization, distribute laboratory exercise on pasteurization. Have students complete assigned exercise.

7. Perform a demonstration on mixing a growing media for a specific crop.

VIII. Application procedures:

1. The main purpose of this problem area is to teach the students how to mix a growing media for specific crops and to recommend procedures for pasteurizing soils.

2. The students will also gain an awareness of the characteristics of a good growing media, the equipment necessary for mixing a growing media, and the media which are comredily available.

VIII. Evaluation:

1. Prepare and administer a paper and pencil test using the Sample Test Questions as possible test items.

2. Collect and evaluate laboratory exercises.

3. Give credit for selecting, preparing, and mixing a proper growing media.

IX. References and aids:

1. Teachers Guide

2. Laboratory Exercises on:

   a) Effect of Pasteurizing Soil on Plant Growth
   b) Selecting and Mixing Propagation Media
   c) Mixing Fertilizer with the Soil
   d) Mixing Soil on the Floor
   e) Mixing Soil with Concrete Mixer
   f) Mixing Soil on a Potting Bench
   g) Soil Preparation for Seeding or Sodding

3. Sample Test Questions

4. Information Sheets On:

   a) Pssteurizing Soil Media
   b) Limitations of Methyl Bromide
   c) Treatment, Temperature, and Time
   d) Comparative Advantages of Steam and Chemical Treatments of Soil Media
   e) Soil Volume Equivalents
   f) How Many Pots to the Bench

5. 50 Laboratory Exercises For Vocational Ornamental Horticulture, Compiled by Paul Hemp, Published by Interstate Printers and Publishers, Danville, Illinois.

   a) Effect of Over-Sterilization of Soil on Plant Growth"
   b) Mixing Potting Soil

6. VAS Unit #5024, "Soils for Plant Growth - Standardized Growing Media."

7. University of Illinois - Cooperative Extension Service - Horticulture Facts. a) FL-6-79 "Container Soil Amendment: What Happens When We Mix Soils"

8. Greenhouse Soils by Dr. Paul E. Rieke and Dr. Darryl D. Arnche, Lamotte Chemical Products Company Chestertown, Maryland 21620, 1975 Publication 36 pp.

9. The Greenhouse Environment by John W. Mastalerz, John Wiley & Soms, Inc., New York, 1977 pp. 341-385.

10. Transparency's

INFORMATION SHEET
PASTEURIZING SOIL MEDIA

Terms to Know

Bacterium:	A microscopic unicellular plant that lacks chlorophyll and reproduces by dividing into two parts.
Damping Off:	Decay or rotting of seed or stem near the soil surface.
Fumigant:	A volatile pesticide that kills by its vapors.
Fungus:	A plant with no chlorophyll, reproducing by sexual or asexual pores, with mycelium and well-worked nuclei.
Gall:	Outgrowth or swelling of unorganized plant cells, the result of attack by insects, fungi, bacteria, or nematodes.
Grey Mold:	An aerial plant mold which destroys the plant above ground level.
Infection:	The process by which a parasite gains entrance and becomes established in the host.
Nematode:	Minute worm-like animal; some types feed on or in plants.
Pasteurization:	Heating to kill selected organisms.
Root Rot:	Decay of plant roots because of cultural practices and/or infection.
Stem Rot:	An aerial decay of the plant--this may be right at the soil.
Sterilization:	Heating to kill all organisms.
Stunting:	Reduced size or vigor because of infection.
Water Mold:	A primitive type of fungus that lives in very moist soil; some are able to parasitize plants.
Wilt:	Drooping of plants because of inadequate water supply or excessive transportation, a vascular disease interfering with water transfer.

INFORMATION SHEET
LIMITATIONS OF METHYL BROMIDE FOR FUMIGATION OF BEDDING PLANT SOILS
Provided by Vaughn-Jacklin Corporation

Do not use to treat soil in which carnations or salvia are to be grown.

The germination of the following seeds has been reduced when planted in treated soil. This may be especially true in soils that are high in clay or organic matter.

Ageratum

Alyssum

Antirrhinum (Snapdragon)

Aster

Calendula

Chrysanthemum

Cleome

Coleus

Coreopsis

Datura

Dianthus

Digitalis

Godetia

Helichrysum

Iberis

Lobelia

Myosotis

Nemesia

Nierimbergia

Portulaca

Salpiglossis

Salvia

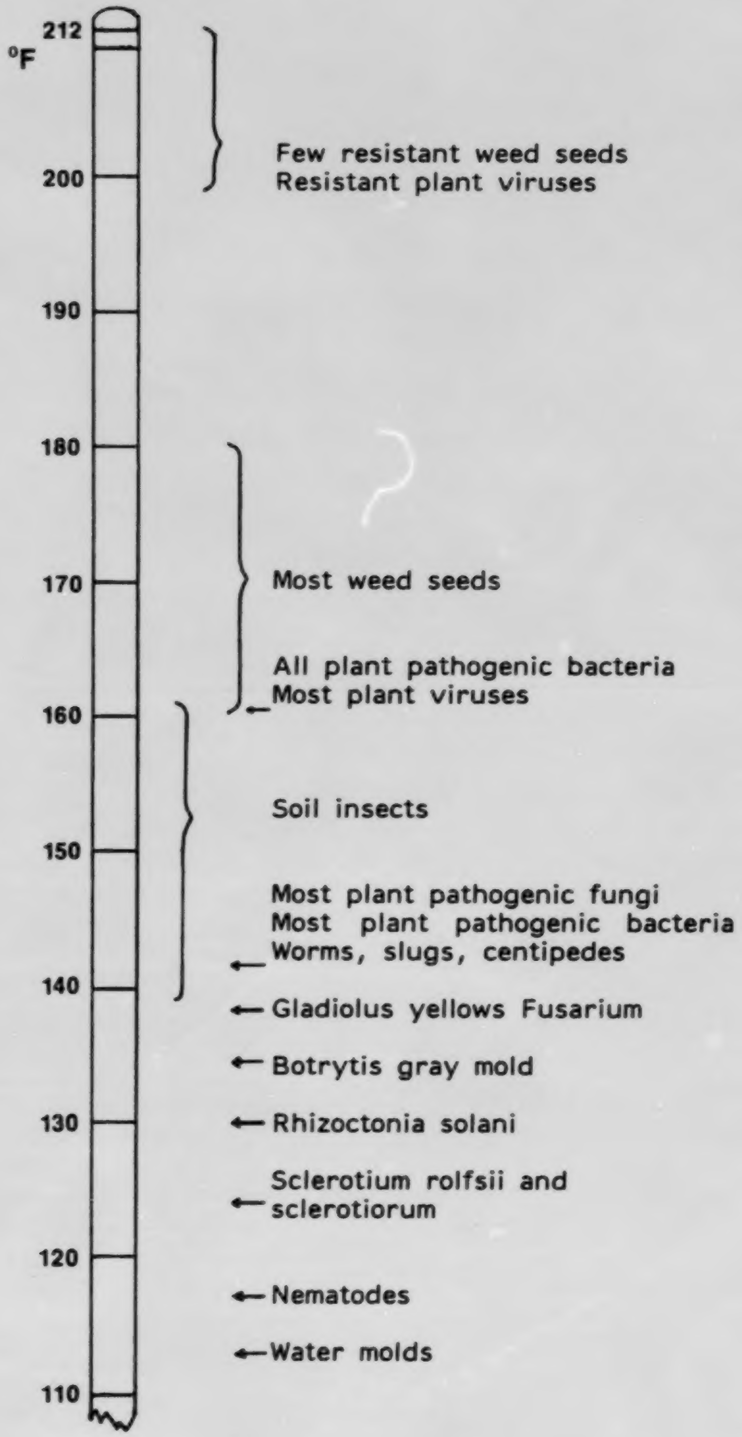
Verbena

Viola

Vinca

INFORMATION SHEET
TREATMENT, TEMPERATURE AND TIME

Temperatures necessary to kill pathogens and other organisms. Most of the temperatures indicated here are for 30-minute exposures under moist conditions. (After Baker, et al)



INFORMATION SHEET
COMPARATIVE ADVANTAGES OF STEAM AND CHEMICAL TREATMENTS OF SOIL IN COMMON USE IN CALIFORNIA NURSERIES (AFTER BAKER)

Provided by Vaughn Jacklin Corporation

Characteristic	Steam, 180°-212°F for 30 min.	Methyl bromide 4 lbs. per 100 cu. ft.	Chloropicrin 5 cc per cu. ft.
Time required for treatment	About 1 hr.	24-48 hr.	2-3 days
Time between treatment and planting	About 1-2 hr. to cool	24-48 hr.	7-10 days
Kills all pathogens, weeds, and insects?	Yes, best treatment; a few weeds survive	Most, but not Verticillium; a few weeds survive	Ues, a few weeds survive
When can penetration of material be determined, as a measure of effectiveness?	At once, by measured soil temperature	Later, by noting reduction of disease or pathogen	Later, by noting reduction of disease or pathogen
Toxic after-effect to crops?	None with U.C. - type soil mixes	Yes, for carnations and some others	None when properly aerated
Use near living plants?	Yes	Within 3 ft. if adequately ventilated	Only with excellent ventilated
Destroys organisms in unrooted crop refuse?	Yes	Yes	Poorly
Can it be used anywhere?	Only if portable boiler is used	Yes	Yes
Is its use limited by environment?	Time and cost increase with cold or wet soil, but can be so used.	Not recommended below 60°F.	Dosage increase if soil below 65°F or wet
Ease of application	Easy	Easy	Obnoxius and Time consuming

Characteristic	Steam, 180°-212°F for 30 min.	Methyl bromide 4 lbs. per 100 cu. ft.	Chloropicrin 5 cc per cu. ft.
Dangerous to workmen?	No	Yes	Yes
Is large capital outlay required?	Yes if boiler is unavailable	No	No
Cost per cu. ft. of soil, exclusive of labor	Less than 2 cents, including equipment cost	About 2.9-3.2 cents, excluding equipment cost	About 1.9-3.0 cents excluding equipment cost

LABORATORY EXERCISE
EFFECT OF PASTEURIZING SOIL ON PLANT GROWTH

I. Purpose:

To show the effects of pasteurization on plant growth and development.

II. Materials

1. Soil mixture sufficient to fill two small flats.
2. Two small flats (or pots).
3. Thirty rooted herbaceous cuttings.
4. Oven.
5. Thermometer.

III. Procedures:

1. Fill the two flats or pots with soil mixture.
2. Place flat number one in the oven and pasteurize the soil by maintaining the soil temperature at 180 degrees F. for 30 minutes.
3. The next day plant 15 cuttings in flat number one and 15 cuttings in flat number two.
4. Observe the plants each day for 30 days.

IV. Questions:

1. What effect did the soil that was pasteurized have on plant growth?

2. Why was there a difference in plant growth?

3. Summarize the differences in the two flats every ten days.
   10 days:

   20 days:

   30 days:

LABORATORY EXERCISE
STEAMING SOIL

I. Introduction:

A very serious problem in the nursery business is the loss of plants killed or damaged by insects and disease organisms or weeds in the soil. State and federal quarantine laws permit only the shipment of nursery stock that is free of diseases, insects, and weeds.

Steaming is the fastest, easiest and least expensive of all methods for controlling these problems in soil. The steam is applied until the soil has reached a temperature of 180°F and is continued for 30 minutes.

II. Procedure:

1. Test the soil for moisture content by squeezing it in your hand. It should hold a ball shape. If it is too wet, allow it to dry for several days. If it is too dry, sprinkle it with water, mix, and test again, repeating if necessary.

2. Place soil loosely in a greenhouse bench, on a canvas on the floor, or in flats for a steam box (use wooden "spacers" between flats).

3. Connect steam hose to steam outlet and place open end at the bench end, at the edge of the soil mound (if on a floor), or connect to the steam box.

4. Place the steaming cover over the soil. Place a heavy chain, pieces of metal water pipe or other heavy objects near the edge of the cover. If a steam box is used, close the cover tightly.

5. Slowly open steam valve to allow steam to inflate the plastic cover enough to lift it off the soil surface. Adjust the value to hold the cover in this position. Too much pressure will blow off the cover. If using a steam box, adjust valve so only a little steam escapes from cracks in the box.

6. Plunge the thermometer through the cover into the soil at the point farthest from the steam inlet. After the theromoter registers 180°, continue steaming for 30 minutes. Soil in a box should be steamed for a total of 45 to 60 minutes.

7. When the steaming time has ended, turn off the steam and remove the cover or open the door to the steam box. Use care - steam can severely burn exposed skin!

8. Do not plant until the soil is cool to the touch.

9. Uncover the soil right after steaming to let the steam escape. If the steam condenses to form water in the soil, the soil may become so wet that it cannot be used for several days. If fertilizer is needed, it should be mixed in after steaming, when soil has cooled, otherwise plants may be severely injured.

III. Observations:

LABORATORY EXERCISES
MIXING FERTILIZER WITH THE SOIL

I. Objective:

Given a 10-10-10 fertilizer and 2 bushels of mixed soil, the student will be able to mix the fertilizer into the soil.

II. Introduction:

Plants grown in containers require more careful fertilization than plants grown in large planting spaces or fields because the soil volume is small. Plants use nutrients rapidly when the roots are in a small amount of soil.

It is important that the medium be moist at the time of mixing the fertilizer with it. A complete fertilizer contains nitrogen, phosphorus, and potassium (NPK, 10-10-10).

III. Procedure:

1. If the soil is dry, sprinkle it lightly with water and mix thoroughly before going to Step 2.
2. Spread one wheelbarrow (2 bushels) of soil medium about 4 inches high on table.
3. Fill a 4-inch flower pot, spread fertilizer evenly over all the medium on the table.
4. Using the filled flower pot, spread fertilizer evenly over all the medium on the table.
5. With shovel, start mixing from one end of pile by scooping the shovel full of medium from front to back.
6. Turn the medium over with the shovel.
7. Repeat Steps 5 and 6 until all medium has been turned.
8. Repeat Step 7 about two minutes or until fertilizer is equally distributed throughout the medium.
9. With shovel, scoop soil mixture into a pile.

Note: The soil should be moist enough to hold a ball shape that crumbles easily after being squeezed in the hand.

This is an example of how fertilizer may be mixed. The kind and amount of fertilizer required for the crop for which a particular soil is being prepared must be determined.

LABORATORY EXERCIES
MIXING SOIL ON THE FLOOR USING A WHEELBARROW TO MEASURE VOLUME

I. Objective:

Given soil, sand, and peat, prepare an evenly mixed soil medium of one part peat, one part sand, and one part soil, using the wheelbarrow to measure the volume. Performance is evaluated by teacher using guide on the back of this sheet. Teacher will specify the volume of soil mixture required.

II. Introduction:

Large volumes of soil are usually mixed on the floor using a wheelbarrow to measure amounts of soil, sand, and peat.

Soil moisture is a very important factor to consider when mixing soil media. A good way to test soil for moisture content is to grasp a handful of soil, squeeze it, and then open the hand. If the soil falls apart, it is too dry; if soil stays lumped together, it is ready for mixing; and if the soil runs between fingers, it is too wet.

III. Procedure:

1. Spread canvas sheet on floor before mixing is started.
2. With shovel, spread one wheelbarrow load of peat evenly over the canvas.
3. Spread one wheelbarrow load of sand on top of the peat.
4. Spread one wheelbarrow load of soil on top of the sand. (Height of soil medium should be from 4 to 6 inches).
5. Start the mixing operation from either side of the pile. With shovel, scoop medium from front to back.
6. Turn and drag shovel slowly across the floor so medium will roll out in a line.
7. Repeat Task 5 and 6 until all medium has been turned.
8. Repeat Task 7 until medium is well mixed.

Note: Soil mediums are steamed after mixing to destroy insects, weed seeds, and disease organisms. Fertilizer should be mixed into the soil only after steaming, or materials very harmful to plants may form during steaming.

LABORATORY EXERCIES
MIXING SOIL WITH A CONCRETE MIXER

I. Objective:

Given soil, sand, and peat, prepare an evenly mixed soil medium of one part peat, one part sand, and one part soil, using a concrete mixer. Performance is evaluated by teacher using guide on the back of this sheet.

II. Introduction:

Large volumes of soil can be mixed in a concrete mixer.

Soil moisture is a very important factor when mixing soil mediums. A general rule to follow when testing soil for moisture content is to grasp a handful of soil, squeeze it, and then open the hand. If the soil falls apart, it is too dry; if it lumps together, it is ready for mixing; and if it sticks or runs between the fingers, it is too wet.

The peat moss often needs to be sprinkled with water before using.

III. Procedure:

1. With shovel, place equal amounts of soil, peat, and sand (3 or 4 shovels of each), in the concrete mixer.
2. Switch concrete mixer on and let turn until the mixture is well mixed. Turn switch off.
3. Test soil by the "lump" method for soil moisture. If it is too dry, sprinkle about 1 quart of water over the soil, repeat Step 2, test the soil again. Repeat until the soil has the correct water content.
4. Grasp level on mixer and dump medium from mixer into wheelbarrow.
5. With shovel, remove medium from wheelbarrow and put in storage bin or, if directed, on table for mixing fertilizer with soil.

Note: If steamed ingredients are used, fertilizer (if needed) may be added in Step 1. Fertilizer should not be added to soil mixtures before steaming, because substances may be formed that are very harmful to plants.

If steamed ingredients are used, be sure that the cement mixer, shovel, and wheelbarrow have been disinfected before use so the clean soil will not be contaminated.

LABORATORY EXERCIES
MIXING SOIL ON A POTTING BENCH

I. Objective: Given soil, sand, and peat, prepare an evenly mixed soil medium for potting plants. Performance is evaluated by teacher using the guide on the back of this sheet. The teacher will specify the volume of soil mixture required. (Usually from 1 to 2 bushels).

II. Introduction:

There is not standard soil mix for container grown plants. Each nurseryman develops a mix best suited to his or her individual situation.

A basic formula often used is 1 part loam soil, 1 part sand, and 1 part peat. The peat provides for good moisture holding, and both peat and the sand provide good water drainage. If the peat is dry, it should be sprinkled with water before using.

III. Procedure:

1. Spread 8 shovels of peat on the table.

2. Spread 8 shovels of soil over the peat.

3. Spread 8 shovels of sand on top of soil.

4. Starting from either side of the pile, scoop up a full shovel of the medium.

5. Turn and drag shovel slowly across the table so medium will roll out in a line.

6. Repeat Steps 4 and 5 until all soil, peat, and sand have been mixed to give a uniform medium.

7. Test for moisture content by squeezing a handful of the soil mixture. If it holds a ball shape that crumbles easily, the moisture level is right for potting. If the soil ball falls apart, the mixture is too dry.

8. If the soil mixture is too dry, sprinkle about 1/2 gallon of water over the surface, thoroughly mix the soil, and test for moisture again. Repeat until a soil ball holds together.

9. With the shovel, pull the soil together into one pile on the table.

Note: If the ingredients were steamed before mixing, avoid contaminating the mixture. Use a potting table that was disinfected and a shovel that was steamed or thoroughly cleaned. If the ingredients were not steamed prior to mixing, the mixture may be steamed after this task is completed.

If fertilizer is to be incorporated, it should be spread evenly over the sand at the end of Step 3. Fertilizer should be mixed in only after soil mixture has been steamed. If soil mixture containing fertilizer is steamed, substances very harmful to plants may be formed.

LABORATORY EXERCISE
SOIL PREPARATION FOR SEEDING OR SODDING

I. Objective:

Given an area to be planted in turfgrass, appropriate equipment, tools, and materials, the student is able to prepare an area for seeding or sodding.

II. Introduction:

This exercise assumes that the area has been rough and finish graded, has about 6 inches of topsoil, and that results of a soil test report are on hand.

III. Procedure:

1. Determine whether the soil is in proper moisture condition to be tilled.
2. Apply ground limestone, superphosphate, and sulphate of potash separately at rates recommended by the soil test report, using a fertilizer spreader.
3. Using tractor and plow, or power tiller, turn over the soil to a depth of 6 inches.
4. Use tractor and disc (if power tiller not previously used) to break up soil.
5. Use harrow and/or drag to smooth the soil, making at least 4 passes from different directions.
6. Use spade and rake to fill in hollows and smooth humps. Remove all stones, sticks, and trash.
7. Roll lightly; smooth again with drag.
8. Apply the complete fertilizer at the rate recommended by the soil test report, using a fertilizer spreader.
9. Rake the complete fertilizer into the top 1 inch of the prepared soil surface.
10. Remove all rubbish from the site, sweep walks and drives, remove all equipment, tools and materials from the site.

Note: Ideal in northeastern states, lawn seeding should be done in August or early spring, while sodding is best done in May or August.

LABORATORY EXERCISE
SELECTING AND MIXING PROPAGATION MEDIA

I. Purpose:

A successful plant propagation program begins with the propagation medium. Although there is no standard recommendation for a propagating mix, a medium whether used singly or in a combination should show four basic characteristics: 1) Sufficient density and firmness to hold the cutting, 2) Sufficient moisture retention ability, 3) Sufficient porosity to drain away excess water and 4) Be clean and sterile. Therefore, the student should be able to identify all the materials being used in the laboratory or propagating media with 100% accuracy and be able to measure and use the materials proportionally (by volume) to produce a propagating mix of a predetermined ratio.

II. Procedure:

1. Locate the assigned mixing area you are to work and the tools you are to work with.

2. Be sure the area is clean and will hold the volume of propagation medium you plan to mix.

3. Locate the materials that will be used in the propagation mix.

4. Stop! Carefully read the predetermined ratio of recommended materials to be used in the propagation medium. The ratio and materials should have been supplied by the instructor.

5. Remove the amounts of each material indicated by the ratio and place them into the mixing area.

6. Slide the mixing shovel into the base of the pile and lift up and over at the same time.

7. Continue this bottom-mixing technique for at least five minutes.

8. Place the mixed propagation medium into the propagation flats and onto the propagation bench.

III. Observations:

STEAM AND CHEMICAL SOIL STERILIZATION

TREATMENT	ADVANTAGES	DISADVANTAGES
STEAMING	A very effective job. Cost of treatment is less per sq. ft. than for chemicals.	High initial cost. Edges of benches and growing areas may not receive steam. After steaming, problems frequently occur.
FUMIGATION (CHEMICAL)	Useful when a source of steam is not available. Gives good control of insects, weeds, and nematodes.	Cost of treatment per sq.ft is high. Not very effective against hard-to-kill organisms. A great deal of time is required for aeration after treatment.

KILLING TIME FOR VARIOUS SOIL ORGANISMS WHEN USING STEAM PASTEURIZATION

ORGANISM	TIME TO KILL	TEMPERATURE
Nematodes	Instantly	140° F.
Soil insects	Instantly	140° F.
Soil fungi	10 minutes	140° - 160° F.
Soil bacteria	10minutes	140° - 160° F.
Weed seeds	10 minutes	140° - 160° F.
Soil virus	30 minutes	180° F.

SAMPLE TEST QUESTIONS AND TEACHER'S KEY
PASTEURIZING, PREPARING AND USING A GROWING MEDIA

1. Match:

1 a. Sterilize

2 b. Leaching

4 c. Fumigant

3 d. Nematode

5 e. Pasteurize

(1) A chemical that kills all living things in the soil and renders the soil unusable for plants for one to several years.

(2) The dissolving out of toxic materials from soil by running water or percolating water through the soil.

(3) A small round worm that lives in the spil and does much damage.

(4) A chemical whose vapors are capable of destroying soil-borne insects, bacteria, and weed seeds in an enclosed space.

(5) To heat the soil just long enough to kill the harmful micro-organisms in the soil.

2. Name three methods of pasteurizing soil.

a. chemicals

b. electricity (oven heat)

c. steam

3. Identify as true or false each of the following statements concerning the purposes of steam sterilizing.

T (1) Kill soil-borne insects.

T (2) Kill all of the bacteria, fungi, and virus organisms that are harmful to commercial crops.

T (3) Destroys weed seeds.

F (4) Promotes fertility in the soil.

T (5) Promotes soil granulation.

4. Which one of the following statements best sums up the importance of nursery or greenhouse sanitation? Underline the correct response.

a. The clean nursery or greenhouse looks nice.

b. b. Using clean tools and fumigated soil mix reduces disease and allows increased production.

5. List at least four precautions to observe in using chemical soil fumigants.

   a. do not plant fumigated soil for two weeks

   b. avoid inhaling the material

   c. avoid skin contact

   d. allow for time aeration

6. Describe damping off and tell what might be the cause.

   decay or rotting of seeds of stems near the soil surface causes:

   too cool temperatures, over watering, too humid, pests

7. Identify as true or false each of the following fumigants that are particularly effective against nematodes:

   T a. Dichloropropene-dichloropropane mixtures.

   T b. Ethylene di-bromide.

   F c. Fly sprays.

8. Name three sources of disease problems in nurseries or greenhouses.

   a. tools used in infected areas

   b. soil not pasteurized

   c. cuttings or seeds infected prior to planting

9. Identify as true or false each of the following phrases concerning the conditions under which soils are sterilized by chemicals:

   T a. When overhead costs are so low that the time required for aeration is not expensive.

   T b. When weed seeds and soil-borne insects are the main reasons for sterilization.

   T c. When steam boilers are not available for sterilization.

   F d. During war when poison gas is more available.

10. State at least four steps in preparing the soil for steaming.

   a. test soil for moisture

   b. mix soil to aeriate the media

   c. add organic material prior to steaming

   d. check soluble salt level

11. Name at least five factors to consider in chemically fumigating soil.

   a. is there any other less costly method

   b. can the crop being planted tolerate the chemical

   c. can the employees be protected from the hazards

   d. can time be permitted for chemical fumigation

   e. will this method control the pest

12. Identifying as true or false each of the following possible solutions to problems that may occur after steaming:

   F a. Avoid sterilizing in cold water.

   T b. Use high-quality, long-lasting kinds of peat such as German or Canadian sphagnum peats, or other forms of organic matter that break down slowly.

   T c. Don't feed the previous crop after it shows color, and leach it during the last watering.

   T d. Keep soils cultivated during critical periods to encourage airto enter the lower soil.

   F e. Keep soils very dry when steaming.

13. State the length of time and temperature to steam soil.

   30 minutes at 180°

14. State at least two problems that are likely to occur after steaming soil.

   soil may nitrify

   beneficial organisms may be killed

   ammonia may build up and burn roots

15. a. State two advantages for using domestic peats in medium mixes.

large quantities available in the United States

Not as costly as the imported types

50% lighter than othe mixes

b. State two disadvantages for using domestic peats in medium mixes.

variability in nutrient levels, decomposition rate

weed seeds, acidity, nematodes

16. List the three ingredients used in the medium mixture for potting rooted cuttings and young seedlings.

a. sand

b. loan

c. peat moss

17. Identify by true or false each of the following ingredients that made up the medium mixture known as the "Texas A & M" mixture.

T (a) 13.5 cu. ft. horticulture grade perlite.

T (b) 13.5 cu. ft. sphagnum moss.

T (c) 5 lbs. 20% super-phosphate.

T (d) 10 lbs. Dolomite.

F (e) 6 lbs. coarse rocks.

T (f) 5 lbs. of complete fertilizer (8-12-4)

T (g) 3 oz. chelate of iron.

18. Name the two basic ingredients in the "California mixture."

a. sand

b. peat moss

19. Choose from the following statements those that apply to soilless, artificial medium mixtures.

X (a) Grower can obtain fairly reproducible results for his plants.

____ (b) Iron never needs to be applied to this mixture.

X (c) Trays containing this mixture are 50% lighter than the peat, sand, loam mix.

20. Name one soiless, artificial medium mixture.

California Mix

21. Identify as true or false each of the following ingredients that make up the mixture for general container ground nursery stock.

T (a) 1 part sand

T (b) 2 parts loam soil

T (c) 1 part peat moss

F (d) 3 parts nutshells

T (e) 1/2 part sawdust or wood shavings

22. How soon before use should the materials be mixed?

the soil media can be mixed at any time and

should be pasteurized just before use

23. How much moisture should be in the mixture at the time of use?

slightly moist

24. How are soil materials best mixed when rather small quantities are needed?

wheel barrow, on a mixing bench

25. How are soil materials best mixed when large quantities are needed?

concrete mixer, on the floor of the soil room

26. Describe an "ideal" soil mixture.

large quantities available, not costly, light weight

has water holding capacity, has a known C.E.C.

27. Identify the following equipment and/or soil media.

a. Soil mixer

b. Chemicals

c. electrical sterilizer

d. California mix

e. peat-light mix

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

UNIT J: SOIL SCIENCE AND CONSERVATION OF NATURAL RESOURCES

PROBLEM AREA: COLLECTING SOIL SAMPLES FROM THE GREENHOUSE, GARDEN AND LAWN AND APPLYING SAMPLE TEST RESULTS

SUGGESTIONS TO THE TEACHER:

This instructional packet is designed for use with freshman or beginning students enrolled in a horticultural or agricultural occupations program. The recommended time for teaching this problem area is late fall before the soil freezes or in the spring after the soil temperature is above 32°. The estimated time for teaching this problem area is 4 to 8 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. It is important that beginning students receive instruction pertaining to the objectives and methods of obtaining soil samples. This problem area addresses itself to the established and recommended procedures as proposed by the Department of Agronomy, the Cooperative Extension Service of the University of Illinois, and the Agricultural Stabilization and Conservation Service.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this packet are for reference or modification as instructors adapt this problem area to their local situation.

CREDIT SOURCES:

The materials were developed through a funding agreement, R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide, worksheets, and sample test questions were developed by Jerry Pepple and James Ethridge, Department of Vocational and Technical Education, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers.

The student worksheet on "Soil Sampling" was adapted from materials written by Samuel J. Yant, Department of Agricultural Education, The Pennsylvania State University, University Park, PA 16802. The Information Sheets "Optimum pH Range For Vegetable Crops", and "Soil Test Interpretations For Vegetable Crops" were provided by the Vegetable Crops Division of the Horticulture Department, University of Illinois.

TEACHER'S GUIDE

I. Unit: Soil science and conservation of natural resources

II. Problem area: Collecting soil samples frm the greenhouse, garden and lawn and applying sample test results

III. Objectives: At the close of this problem area students will --

1. Know the materials needed for sampling soil.
2. Understand the steps to follow in sampling soil.
3. Know the recommended number of samples to take in fields, lawns, gardens, and flower beds.
4. Be able to determine the fertility needs of various soils based on soil sample analysis results.
5. Understand the importance of soil pH.
6. Understand the primary functions and limitations of soil tests.

IV. Suggested interest approaches:

1. Lead a discussion on soil sampling by asking students if they have ever taken soil samples.
2. Take the class on a field trip to a soil testing laboratory.
3. Have a local fertilizer dealer as a guest speaker to discuss the importance of proper soil fertility.
4. Have students interpret results from the soil test results of their of their S.O.E. projects.
5. Have a fertilizer dealer discuss and help interpret the soil test results.
6. Lead a discussion on the problems of using too much or too little fertilizer in a field.
7. Have students test soil in class with a Sudbury Soil Test Kit.

V. Anticipated problems and concerns of students:

1. Why do we take a soil sample?
2. What factors influence the number of samples to be taken?
3. What is the procedure to follow in taking a good soil sample?

4. How are the samples correctly prepared and packaged for testing or sending to a laboratory?

5. Why is information about past history and yield included with the samples?

6. When and how often should a soil sample be taken?

7. What are some things to avoid when taking a soil sample?

8. What soil testing services are locally available and is there a charge?

9. How do I take soil samples from greenhouse bench crops, nursery and greenhouse potted crops, and plants in the home?

10. How much fertilizer do I need to put on my field? Lawn? House plants? Vegetables?

11. What does N, P, and K mean?

12. What does pH refer to in a soil?

13. How does pH affect crop yields?

14. How do I determine the amount of fertilizer to use from these results?

15. How often do I need to take soil tests?

16. What are some limitations of soil tests?

VI. Suggested learning activities and experiences:

1. Have class read VAS Unit 4001 and record tentative answers to the problems and concerns identified by the class and instructor.

2. Distribute Soil Sampling Worksheet and have students complete the blanks.

3. Show transparencies

    a. Following instructions and sampling tools.

    b. Watching for unusual areas.

    c. Taking samples from each area.

4. Distribute the soil test report forms.

5. Show transparencies
    a. Completing the information sheet.
    b. Follow test recommendations.
6. Distribute the Laboratory Exercise on Obtaining Soil Samples from Lawns, Gardens, and Flower Beds and Form A.
7. Discuss important facts concerning soil sampling from lawns, gardens, and flower beds.
8. Discuss how to complete Form B.
9. Take students on a field trip to collect soil samples or make this an out-of-class assignment.
10. Have class read Soil Test Forms D-1, D-2, D-3, D-4. Record tentative answers to the problems and concerns identified by the class and instructor.
11. Present and discuss transparencies 22 through 36 as students complete Worksheet "Soil pH".
12. Hand out Worksheet "Phosphorus and Potassium". Show transparencies 37, 38, 44, 45, 47.
13. Hand out and discuss "Soil Testing Services in Illinois."
14. Identify and discuss the following tools and supplies:
    a. A supply of small paper sacks.
    b. A box or basket for carrying the samples.
    c. A pan or bucket for mixing the samples.
    d. A trowl, spade, soil probe or auger to dig the samples.
15. Have students develop maps of their sampled area showing pH, P_1, and K.
16. Have each student make an oral or written report explaining the results of their soil tests.
17. Show a film on soil fertility, such as:
    a. "Making the Most of a Miracle."
    b. "Nutrient Deficiency Symptoms in Plants."

    c. "Our Living Soil."

18. Have the students perform their own soil tests using a Sudbury soil test kit and a pH meter. Use VAS 4002a, 4003b, 4004b for procedures.

VII. Application procedures:

1. Have each student take soil samples from his home, greenhouse, or house plants for testing.
2. At the close of this problem area the student will be able to explain the fertility recommendation on a soil test and determine an appropriate fertility program on his SOEP or other assigned project.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test using the Sample Test Questions as possible test itmes.
2. Collect and grade Student Worksheets.
3. Give credit for oral or written reports.
4. Give credit for completing own soil tests.
5. Have students demonstrate how to collect a soil sample and prepare it for testing.

IX. References and aids:

1. Teacher's Guide
2. Vocational Agriculture Service Units:

    a) #4002a pH Test For Soil Acidity
    b) #4003b Testing For Phosphorus
    c) #4004b Determining Available Potassium in Soils
    d) #4001 Collecting and Preparing Soil Samples For Testing

3. Vocational Agriculture Service Transparencies and Discussion Guide "Soil Testing and Fertility"
4. Soil Test Report Forms Available from VAS.

    a) A

    b) B

    c) D-1

    d) D-2
    e) D-3
    f) D-4

5. Information Sheets on:
    a) Soil Test Interpretations (Vegetable Crops)
    b) Optimum pH Range For Vegetable Crops
    c) Soil Test Services in Illinois
6. Soil Sudbury Soil Test Kit and a Pit Meter
7. Sample Test Questions and Teacher's Key
8. Student Worksheets on:
    a) Soil pH
    b) Phosphorus and Potassium
9. Laboratory Exercises on:
    a) Obtaining Soil Samples from Lawns, Gardens and Flower Beds
    b) Sampling Greenhouse Soils
    c) Soil Sampling
10. Films are available on a loan or rental basis from:
    a. Film Loan Service, Division of Education, Department of Conservtion, 113 State Office Building, Springfield, IL. 62706.
    b. The Farm Film Foundation, 1425 H. Street N.W., Washington, D. C. 2005.
    c. Modern Talking Picture Service, 2323 Hyde Park Road, New Hyde Park, New York 11040.
    (Order through your instructional resource center.)

INFORMATION SHEET

SOIL TESTING SERVICES IN ILLINOIS

In response to inquiries about the location of soil testing services in different parts of Illinois the attached listing is offered. These laboratories submitted soil samples for check testing to the Department of Agronomy, University of Illinois during 1978.

Reliable soil tests provide a valuable service to the people of Illinois. The soil testing program in Illinois is a decentralized service provided by local laboratories. The program is not rigidly regulated by any agency, but acquires direction from the Department of Agronomy and the Cooperative Extension Service of the University of Illinois and the Agricultural Stabilization and Conservation service. These agencies are interested in helping to assure accurate soil tests, valid interpretation of these tests, and practical recommendations for soil treatments to Illinois farmers.

All Agencies interested in the soil testing program agree that all soil testing laboratories in Illinois should meet the following minimum standards.

1. The standard of taking and testing 11 soil samples per 40 acres has been established. Although it may not be practical to adhere rigidly to this standard, one sample for every three to four acres should be used as a guide, depending on the soil-type variations in any field.

2. A recommended soil treatment should be asked on both an interpretation of the soil test results and a knowledge of the field history (cropping and treatment). Laboratories should either refuse samples that are not accompanied by a field history form or should return the results of the soil tests with the notation "Insufficient information for a sound interpretation".

3. The testing techniques provided by the University of Illinois Department of Agronomy must be used in making the tests, and the work must be done by a qualified soil testing technician.

4. The soil test report form should clearly identify the laboratory and should accurately record the results of the soil tests.

5. To maintain an acceptable level of accuracy in the tests, each local laboratory must submit samples to the Agronomy Soil Testing Laboratory for check testing.

6. Recommendations for corrective soil treatment must be made by or under the direct supervision of a qualified person. An agriculture college graduate will be considered qualified if his or her training included work in soils and if he or she has kept abreast of developments in soil technology.

Soil Test Form A

INFORMATION SHEET

DIRECTIONS FOR COLLECTING SOIL SAMPLES

FIELD SAMPLING

Start for the field to collect soil samples only after you understand the importance of sampling and how to do it. Over a period of years, a farmer is likely to invest several thousand dollars on the basis of results obtained from soil tests in a 40-acre field. It is easily possible to make hundreds of dollars for an extra hour spent in careful sampling and recording the location of each sample. The best laboratory tests in the world made on samples that are carelessly taken are not only worthless but may lead you to spend thousands of dollars for plant nutrients that you don't need while you neglect to buy nutrients that your fields lack.

When the soil finally gets into the test tube in the laboratory, about *1 teaspoonful is going to represent 2 to 5 acres. It had better be the right teaspoonful!*

The leaflet is planned to help you to understand how to get samples that will provide a sound basis for investing your money in fertilizer and limestone. Take time to study it.

MATERIALS YOU WILL NEED

A supply of at least 11 small paper sacks (for a 40-acre field).
A basket or box for carrying the samples.
A pan or bucket for mixing the small samples.
A trowel, spade, or auger to dig the samples.

STEP NUMBER 1. PLAN WHERE TO SAMPLE AND HOW MANY SAMPLES TO TAKE.

First check the descriptions under situations A and B to decide which plan to follow.

Situation A. Fields that appear to have only one kind of soil and where recent past cropping and fertilizer and limestone treatments have been the same throughout. You may follow a regular pattern as indicated on the diagrams on the back of this sheet.

For a 10-acre field take 4 samples at locations corresponding to 1, 2, 6, and 7 on the diagram for a 20-acre field.

Each sample shown by a number on the diagram is a mixture of 5 small samples taken within a square rod at the places shown by the x marks. The reason for taking these 5 small samples is to make certain that the whole sample does not come from within a band of fertilizer applied in a previous year.

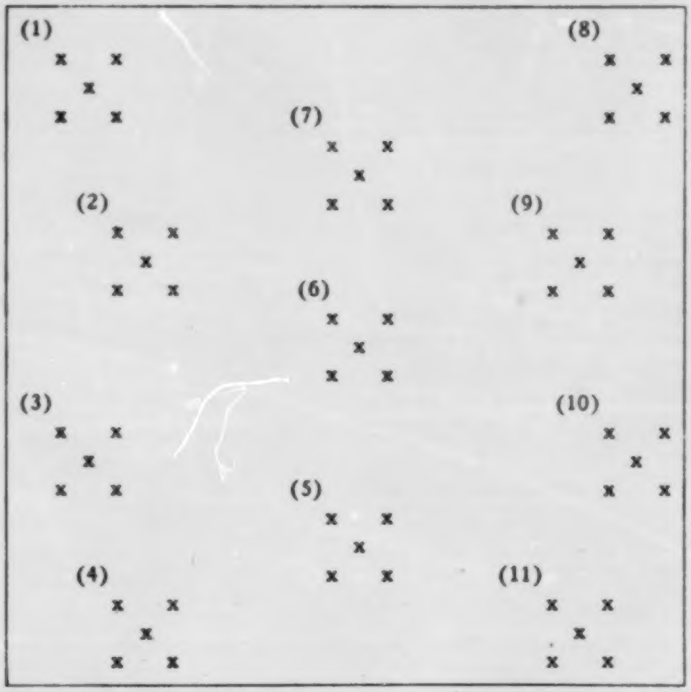
Eleven samples are suggested for a 40-acre field, 7 for 20 acres, and 4 for 10 acres in order to outline areas with different fertility status due to unseen soil differences or differences in previous fertilizer or limestone applications or cropping systems.

Situation B. Fields that have different kinds of soil, that have problem areas, or that have been cropped, fertilized, or limed differently in the past 5 to 10 years.

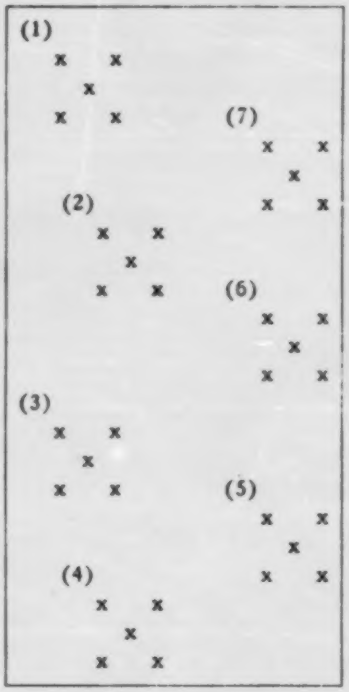
The same general suggestions apply as outlined under situation A, but you will want to take enough additional samples to fully represent the different conditions within the field. This is a matter of judgment, but remember that a few extra samples take little time or money but may give a much better picture of the fertility status of the field. Fields are sampled only once in 4 to 8 years. Don't gamble on short cuts to a good sampling job.

INFORMATION SHEET

40-acre field



20-acre field



STEP NUMBER 2. TAKE THE SAMPLES AND RECORD THE LOCATION OF EACH SAMPLE AND OUTLINE LOW SPOTS, KNOLLS, DRAWS, ETC., ON THE MAP.

This information is needed to help you or the person who interprets the tests arrive at the proper treatment. If you plan to treat according to soil tests, *then you must know where each sample came from!*

STEP NUMBER 3. PREPARE THE SAMPLES FOR TESTING.

Let the samples air-dry with the tops of the containers open for several days. Don't rush the drying process by placing samples on a stove or radiator. This will produce misleading test results.

Break up clods and lumps so the soil will pass through ordinary window screen. The samples are ready for testing.

STEP NUMBER 4. FILL OUT THE INFORMATION SHEET, SOIL TEST FORM B.

This form lists the cropping history, previous fertilizer, lime, and manure treatments, and other information to supplement the information supplied by the soil tests and thus lead to more sound fertility suggestions. *The soil test is an important tool in diagnosing fertility needs and in suggesting treatments, but it should never be the only tool.* Here is an illustration to prove the point. If you apply limestone according to the results of a soil test and then retest within two years, the second test will show a considerable limestone requirement even though there is enough in the soil for high yields of legumes. The soil test by itself in this case is misleading.

STEP NUMBER 5. MAIL OR TAKE THE SAMPLES TO THE LABORATORY.

Cooperative Extension Work in Agriculture and Home Economics
University of Illinois College of Agriculture and the United States
Department of Agriculture cooperating. Louis B. Howard, Director.
Acts approved by Congress May 8 and June 30, 1914.

Soil Test Form B

SOIL SAMPLE INFORMATION SHEET

(To accompany soil samples; complete one form for each field)

DATE ____________

____________ County

Township ____________

Section ________ Qtr. ________

Field ____________

Acres ____________

Samples ____________

Tests Desired:

pH ________

P-1 ________

K ________

OM ________

TENANT ____________ ADDRESS ____________

OWNER ____________ ADDRESS ____________

In order that the results of the test may be properly analyzed and interpreted, the following information should be submitted with the samples from each field:

1. Soil type name ____________.
2. Kind of soil: sandy ________ silt loam ________ clay ________ muck ________.
3. Is drainage good ________ fair ________ poor ________?
4. Has the field been limed recently? ________ When? ________ Amount per acre ________.
5. Amount of fertilizer applied per acre last year: N ________ P_2O_5 ________ K_2O ________
6. Cropping intentions for next four years, expected yields, and tillage system (plow, chisel, disk, no-till, etc.):

	Intended crop	Expected yield	Tillage system
This year			
Next year			
Third year			
Fourth year			

7. How deep do you plow? ____________
8. Are there any special problems? ____________

____

____

____

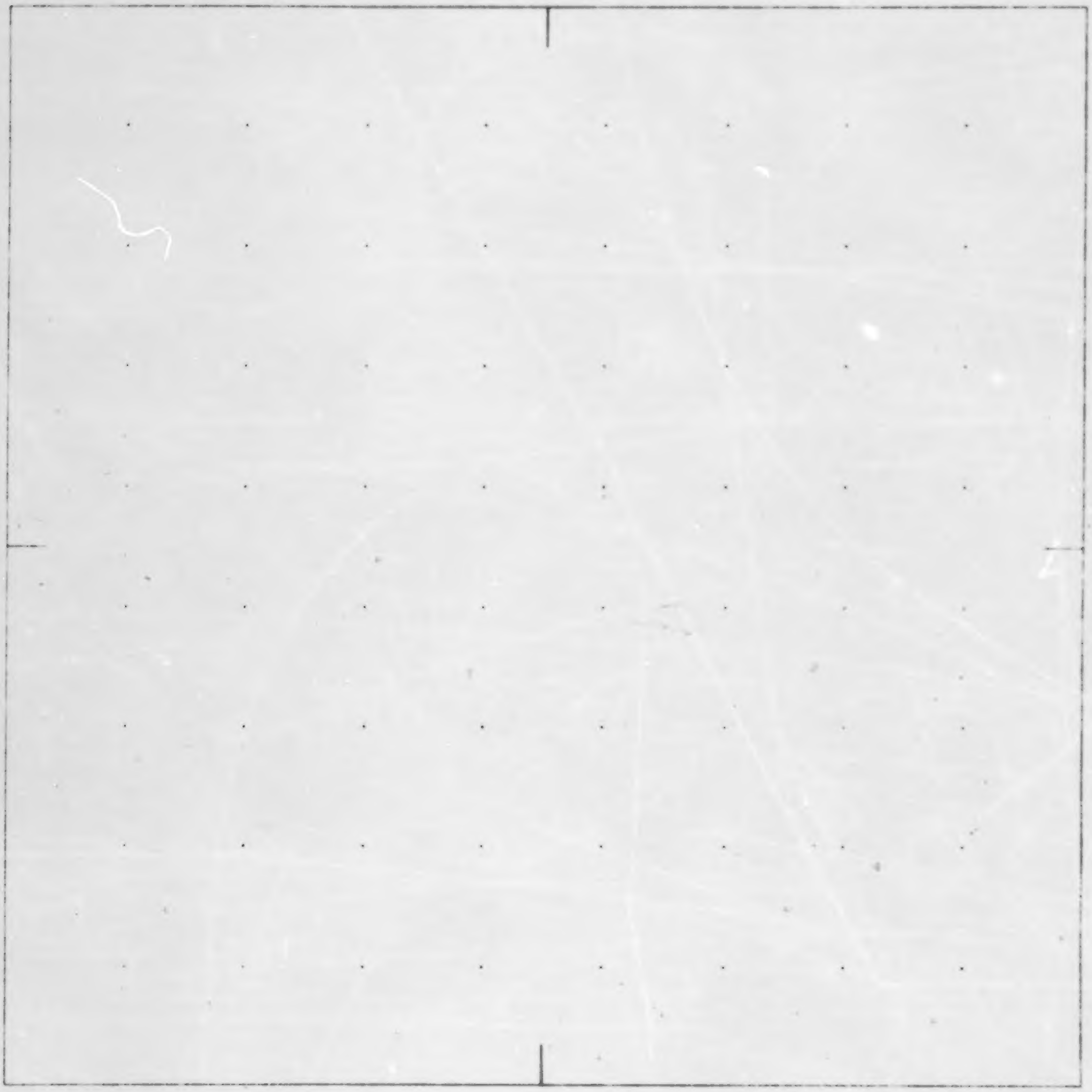
____

Reproduced for classroom teaching purposes with permission of the Cooperative Extension Service

MAP OF THIS FIELD

(Number the sample locations)

Top of map is north



south

Vocational Agriculture Service
434 Mumford Hall
Urbana, Ill. 61801

SOIL TESTING LABORATORIES - ALPHABETICAL LISTING
January 12, 1979

List of laboratories submitting soil samples for check testing to the Department of Agronomy, University of Illinois at Urbana-Champaign during 1978.

1. Agra Soil Service
   U.S. Hwy 20
   Stockton, IL 61085
   JoDavies County

2. Alvey Laboratory
   P. O. Box 261
   209 S. Clinton Street
   Collinsville, IL 62234
   Madison County

3. Belleville Area College
   Dust Kickers Soil Testing
   2500 Carlyle Road
   Belleville, IL 62221
   St. Clair County

4. Brandt's Ferilizer Service Co.
   P. O. Box 276
   Pleasant Plains, IL 62677
   Sangamon County

5. Bruch Laboratory
   Cyndy Bruch
   Box 339, R.R. #1
   Granville, IL 61326
   Putnam County

6. Clark County Soil Testing Laboratory
   R.R. #1
   Marshall, IL 62441
   Clark County

7. Crop Chemical Testing
   R. R. #3, Box 147
   Arcola, IL 61910
   Coles County

8. Cumberland Agri. Laboratory
   P. O. Box 95
   Hazel Dell, IL 62430
   Cumberland County

9. Eastern Illinois Soil Testing
   114 S. Chicago, Box 54
   Rossville, IL 60963
   Vermilion County

10. Edwards County Farm Bureau
    Soil Testing Laboratory
    15 S. Fifth Street
    Albion, IL 62806
    Edwards County

11. Edwards Soil Service
    601 N. Court Street
    Pontiac, IL 61764
    Livingston County

12. Effingham Equity
    Soil Testing Laboratory
    P.O. Box 388
    Effingham, IL 62401
    Effingham County

13. Fayette County Farm Bureau
    Soil Testing Laboratory
    112 N. Sixth Street
    Vandalia, IL 62471
    Fayette County

14. Graymont Co-op Association
    Graymont, IL 61743
    Livingston County

15. Greene County Farm Bureau
    Soil Testing Laboratory
    319 W. Side of Square
    Carrollton, IL 62016
    Greene County

16. Grundy County Farm Bureau
    Soil Testing Laboratory
    116 E. Washington
    Morris, IL 60450
    Brundy County

17. Hamilton County Soil Testing
Courthouse
McLeansboro, IL 62859
Hamilton County

18. Hancock Extension Soil Laboratory
P. O. Box 168
Carthage, IL 62321
Hancock County

19. Kaiser Chemical Co.
Soil Testing Laboratory
Sullivan, IL 61951
Moultrie County

20. Key Agricultural Services, Inc.
114 Shady Lane
Mccomb, IL 61455
McDonough County

21. LaSalie County Farm Bureau
Soil Testing Laboratory
Rt. 23 North, P. O. Box 88
Ottawa, IL 61350
LaSalle County

22. Macoupin County Farm Bureau
Soil Testing Laboratory
210 N. Broad
Carlinville, IL 62626
Macoupin County

23. Marquise Farm Supply, Inc.
Soil Testing Laboratory
Box 279
Clinton, IL 61727
DeWitt County

24. Meiners Farm Service, Inc.
Soil Testing Laboratory
Colfax, IL 61728
McLean County

25. Mid-American Pipeline Co. (MAPCO)
Soil Testing Laboratory
R.R. #2
Athens, IL 62613
Menard County

26. Midwest Soil Testing Service
Danforth, Il 60930
Iroquois County

27. Mississippi Valley Soil Testing
1610 Keokuk, Box 96
Hamilton, IL 62341
Hancock County

28. Mowers Precision Crop
Counseling Service
107 N. Franklin
Toulon, IL 61483
Stark County

29. Irwin H. Parrill
Soil Testing Laboratory
R. R. #2, Box 159
Edwardsville, IL 62035
Madison County

30. Pike County Farm Bureau
Soil Testing Laboratory
125 S. Madison, Box 6
Pittsfield, IL 62363
Pike County

31. Randolph County Farm Bureau
Soil Testing Laboratory
South St. Louis St., Box G
Sparta, IL 62286
Randolph County

32. Richardson Soil Testing Laboratory
R. R. #1
Centralia, IL 62001
Marion County

33. Rich-Law Service Co.
P. O. Box 403
Olney, Il 62450
Richland County

34. Douglas H. Riley
510 S. Euclid Avenue
Princeton, IL 61356
Bureau County

35. Scottland Soil Laboratory
Scottland R#4
Chrisman, IL 61924
Edgar County

36. Sharp's Soil Testing Service
Tyler Evevator
P. O. Box 337
Elwood, IL 60421
Will County

37. Shelbyville Rehabilitation Center
Soil Testing Laboratory
320 E. Main
Shelbyville, IL 62565
Shelby County

38. Shields Soil Service
R. R.
Dewey, IL 61840
Champaign County

39. Skiles Fertilizer Service
Soil Testing Laboratory
P.O. Box 267
Astoria, IL 61501
Fulton County

40. Southern Illinois Farm Foundation
Soil Testing Laboratory
P. O. Box 335
Vincea, IL 62995
Johnson County

41. Sparks Soils Testing Laboratory
122 S. McLean
Lincoln, IL 62656
Logan County

42. Spoon River F.S. Inc.
Soil Testing Laboratory
Ellisville, IL 61431
Fulton County

43. Standard Laboratories
P. O. Box 128
Goodfield, IL 61742
Woodford County

44. Stringer's Soil Service
R.R. #2
Assumption, IL 62510
Christian County

45. Taylor Soil Laboratory
200 Meadow Drive
Macomb, IL 61455
McDonough County

46. Top Soil Testing Service
133 Maple Street
Frankfort, IL 60423
Will County

47. Twin County Service Co.
Soil Testing Laboratory
215 N. 12 Street
Murphysboro, IL 62966
Jackson County

48. Vermilion County Farm Bureau
Soil Testing Laboratory
431 N. Vermilion
Danville, IL 61832
Vermilion County

49. Warren County Farm Bureau
Soil Testing Laboratory
1000 N. Mail Street
Monmouth, IL 61462
Warren County

50. White County Farm Bureau
Soil Testing Laboratory
304 E. Robinson
Carmi, IL 62821
White County

51. Whiteside County Farm Bureau
Soil Testing Laboratory
100 East Knox
Morrison, IL 61270
Whiteside County

52. The Zeller Laboratory
2808 W. 4th Street
Dixon, IL 61021
Lee County

Soil Test Form **D-1**

SOIL TEST REPORT

________________County

Samples brought in by________________________

Date:________________ ________________
(received) (tested)

Samples tested by________________________

Tenant:________________________ Address:________________________

Owner:________________________ Address:________________________

This report gives you the results of the laboratory tests on your samples.

I suggest that you *keep this report in a permanent folder. Record right on the field maps* the amounts of lime and fertilizer that you apply and the dates when you apply them. This record will help you to interpret the next test on the field and will also give you a long-term inventory that will show whether soil fertility is being built up, is being maintained, or is declining.

Field and sample number	Acres	pH Test for acidity	P_1 Test for available phosphorus	K Test for potassium	Organic matter or soil color	Comments

Soil tests are only a means to an end. The important thing is how you use the results to plan a better soil-fertility program. Planning the most profitable soil treatments after you have the results of the soil tests is not simple, but it is extremely important in determining your profit from farming.

On the back of this sheet, and on the other sheets labeled LIME, PHOSPHORUS, or POTASSIUM, you will find the information that you need to understand the tests so that you can plan a more profitable soil-fertility system. If you have further questions, please contact me.

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SOIL TESTS ARE ONLY PART OF THE PICTURE

Soil tests are an inventory of the nutrients and acidity in your soil. You have to decide the kind and amount and when to apply fertilizer and lime. Neither your local dealer nor your extension adviser can give you the answer because only you know the amount of money that you have to invest and the alternative uses for it that you have.

There are several interrelated parts to your crop and soil management programs besides the soil tests. Here are a few.

Cropping system. The fertility needs for various cropping systems are different. For example, a system that includes alfalfa and clover has a high requirement for lime, phosphorus, and potassium, but less need for nitrogen. Corn and soybeans have relatively lower requirements for lime and phosphorus, but corn requires a high level of nitrogen and both crops require a high level of potassium. Because corn returns most of the potassium to the soil in the stalks, the maintenance need for potassium with continuous corn is less than with other cropping systems.

Livestock and manure. If you feed livestock and conserve the manure, you can return about 3/4 of the nitrogen, 4/5 of the phosphorus, and 9/10 of the potassium that is fed. In planning your fertilizer program, you may credit manure with the following nutrients per ton of stable manure if handled carefully to minimize nutrient losses: 10 pounds of nitrogen, 40 to 50 percent available in the first year, 2 pounds of phosphorus (5 pounds of P_2O_5), about 40 percent available in the first year, and 8 pounds of potassium (10 pounds of K_2O), all available in the first year. If the manure has been exposed to considerable leaching, the nitrogen and potassium levels will be much lower.

Production potential of your soil. Through careful study of soil-experiment field data and farm records, the University of Illinois has developed estimates of the yield potentials for many Illinois soils. You can get this information from your extension adviser or other sources in your county.

Good management practices. You will get most profitable returns from fertilizer only if you plow, fit, and plant on time, control weeds, diseases, and insects, and choose the best crop varieties. As you set higher yield goals and apply more fertilizer, it becomes increasingly important to do a good job of farming in every way.

What if the soil test is variable? You may have a large variation among tests on a field and wonder what the reason is and, more important, what to do about it. First look at the pattern of the tests over the field. If there is a definite pattern of high tests in one part and low tests in another, check to see whether there is a difference in soil type. Second, try to recall whether the field was farmed as separate fields at some time in the past. Third, check your soil-test records for this field from previous tests or, if you have no records, try to remember whether the different areas were limed or fertilized differently at some time during the past 5 to 10 years. Whether or not you find the explanation for large differences in tests, you can split the field and apply basic treatments of lime and fertilizer according to indicated deficiencies.

If there is no consistent pattern of high and low tests, then you will have to choose between using the lowest tests or an average of the tests as a guide to the amount to apply. If you find no explanation for large differences in tests, you should consider taking a new set of samples from the field.

What to do about nitrogen? No test has been found to reliably indicate the amount of nitrogen that Illinois soils will supply for a growing crop. You will want to check with your county extension adviser or local fertilizer dealer for the latest suggestions on nitrogen rates.

Vocational Agriculture Service
434 Mumford Hall
Urbana, Ill. 61801

Soil Test Form **D-2**

LIME — MAP AND INTERPRETATION

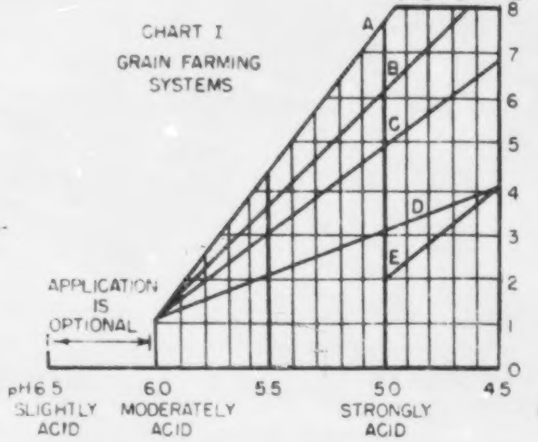
The field map below shows the pH for each sample. Figures on the charts for limestone needed are based on these assumptions:

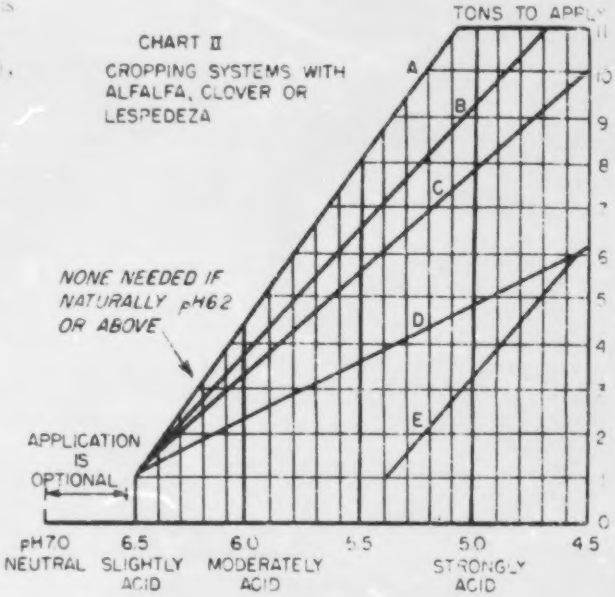
1. A 9-inch depth of plowing. For each inch less, the limestone requirement may be reduced by 10 percent.
2. Typical-fineness limestone — 90 percent through 8-mesh, 60 percent through 30-mesh, 30 percent through 60-mesh.
3. A calcium carbonate equivalent (total neutralizing power) of 90 percent. (See back of sheet for explanation.)

If these assumptions do not apply to your situation, adjust the limestone rate accordingly.

STEPS TO FOLLOW

1. Use Chart I for grain systems and Chart II for alfalfa, clover or lespedeza.
2. Decide which soil class fits your soil —
   - A. Silty clays and silty clay loams (dark).
   - B. Silty clays and silty clay loams (light and medium). Silt and clay loams (dark).
   - C. Silt and clay loams (light and medium), sandy loams (dark), loams (dark and medium).
   - D. Loams (light), sandy loams (light and medium), sands.
   - E. Muck and peat.
3. Find your soil's pH along the bottom of the chart.
4. Follow up the vertical line until it intersects the diagonal line A, B, C, D, or E that fits your soil.
5. Read the suggested rate of application along the right side of the chart that you are using.





SOIL-ACIDITY MAP

REMARKS

If the amount of limestone is 6 tons or more and initial cost is a factor, apply 2/3 the first time and the rest 2 to 4 years later

For more information on liming, see the back of this sheet and also Circular 721 (mimeographed).

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INFORMATION TO HELP YOU PLAN A LIMING PROGRAM

Reasons for Liming

Liming acid soils improves most crops because:

1. It reduces the solubility of manganese and aluminum that are present in strongly acid soils in amounts large enough to be toxic, especially to alfalfa and clover.

2. It improves the soil for microorganisms that speed the decay of plant residues, thus releasing more nitrogen and phosphorus for crop plants.

3. It favors the growth of nodule-forming bacteria (those that take nitrogen from the air) on alfalfa, clover, and soybeans.

4. The best balance in availability of minor elements is found in soils that are neutral or only slightly acid.

5. Phosphorus is more available in soils that are near neutral in acidity than it is in strongly acid soils.

Suggested pH Goals

For cropping systems with **alfalfa** and **clover**, maintain a pH of 6.5 or above. But if the soils have a pH of 6.2 or above without ever having been limed, neutral soil is just below plowing depth and it will probably not be necessary to apply limestone.

For **cash-grain** systems (no alfalfa or clover), maintain a pH of at least 6.0. If the soil test shows that the pH is 6.0, apply limestone to prevent a drop below 6.0. Farmers may choose to raise the pH to still higher levels. After the initial investment, it costs little more to maintain a pH of 6.5 than one of 6.0. The profit over a 10-year period will be affected very little since the increased yield will about offset the original cost of the extra limestone (2 or 3 tons per acre) plus interest. Raising the pH above 6.5 in cash-grain systems unnecessarily increases the risk of nitrogen loss through denitrification.

The amounts of **soil organic matter** that correspond to the color terms used in describing soil classes (excluding sands) on the other side of the sheet are: light — less than 2½ percent; medium — 2½ to 4½ percent; dark — more than 4½ percent.

Liming Materials

Nearly all of the liming material used in Illinois is agricultural ground limestone, commonly called agstone or lime. It may be calcitic (nearly all calcium carbonate) or dolomitic (containing magnesium). The maximum magnesium carbonate content is about 45 percent. There is no area in Illinois where one type is preferred over the other.

The two main characteristics that determine the value of lime are its neutralizing power and its fineness.

The **neutralizing power** (calcium carbonate equivalent) of limestone is its power to neutralize soil acids as compared with the neutralizing power of pure calcium carbonate. The neutralizing power of limestone sold in Illinois ranges from about 65 to 109. The higher the neutralizing power, the more valuable the limestone. Limestone that is in the lower range may be just as good a bargain as that in the higher range *if it is priced in line with the difference in neutralizing power.*

The **fineness**, or size, of limestone particles largely determines the rate at which they react with soil acids. The practical problem is how to compare limestones that differ in fineness and price. Your extension adviser and ASC office have the screen scores showing the fineness of limestone for sale in your area.

If you are liming a strongly acid soil shortly before seeding alfalfa or clover, the values for 1 year in the table at right are the best guide. If lime is applied on sod before plowing for corn, the 4-year values are the best to use. If the fields have been limed in the past and a long-term maintenance application is to be made, the 8-year figures are satisfactory.

Comparative Values of Limestone of Varying Particle Sizes Evaluated 1, 4, and 8 Years After Application

Size fraction	Years after application		
	1	4	8
Through 60 mesh........	100	100	100
30 to 60 mesh..........	50	100	100
8 to 30 mesh...........	20	45	75
Over 8 mesh............	5	15	25

When to Lime

Fortunately limestone may be applied at many points in the crop rotation. It is best to lime soils for the first time 6 months to a year ahead of the alfalfa or clover seeding, but in emergencies limestone that contains a high proportion of 60-mesh material can be disked in (not plowed under) just ahead of seeding.

Retesting Limed Fields

Soil tests within 2 years after liming are unreliable. Where lime has been applied according to soil tests, alfalfa, clover, and other crops will grow well even though the soil still tests more acid than is desired. There is little reason to retest a well limed field more often than about every 4 years. Eight to 10 years is often enough to retest fields with a naturally high pH.

Where high rates of nitrogen (150 pounds or more per year) are applied, retesting is suggested every 4 years because nitrogen fertilizer increases soil acidity.

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

M-1-J-2-20

Vocational Agriculture Service
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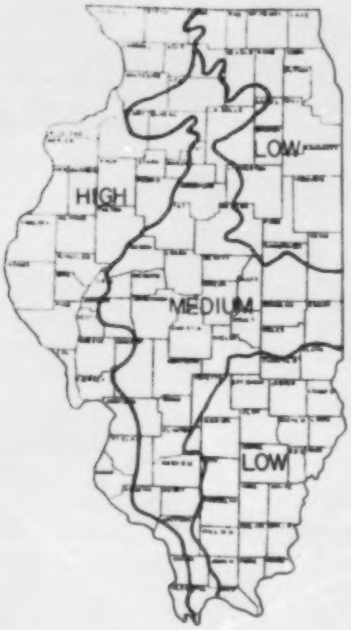
Soil Test Form D-3 PHOSPHORUS — MAPS AND INTERPRETATION

PHOSPHORUS-SUPPLYING POWER



STEPS TO FOLLOW

1. Illinois has tentatively been divided into four regions in terms of inherent phosphorus-supplying power of the soil below plow layer in dominant soil types. These regions are shown on the map of Illinois at left. *Decide into which group your soil falls* with respect to phosphorus-supplying power.

2. Consulting the table at right and the present phosphorus levels on your field as shown on the field map on this sheet, *study the paragraph checked below.*

Suggested Long-Term Goals for P_1 Test Levels

Phosphorus-supplying power	Where row fertilizer is applied for corn	Where no row fertilizer is applied for corn
Low	40–50	50–60
Medium	35–45	40–50
High	30–40	35–45

☐ Phosphorus is below the most profitable level. Phosphorus applications should, therefore, be large enough to not only meet the needs of the next crop but also to raise the soil test level.

☐ Phosphorus is at the suggested level. You may broadcast phosphorus this year and, thereafter, 50 pounds of P_2O_5 annually (or 100 pounds to last 2 years or 150 pounds to last 3 years) to at least maintain the test level until the field is sampled again.

☐ Phosphorus is well above the level believed to be needed. Therefore no yield increase is likely from an application of phosphorus this year.

☐ Phosphorus is so high that you run the risk of creating problems with other nutrients.

3. *Choose between rock phosphate and more available phosphates.* (See back of sheet.)

4. Consulting the table below, *decide where and how to apply the needed phosphorus for maintenance applications on alfalfa and clover.*

P_1 test Soil region (see map)			Percent possible yield	Pounds of P_2O_5 to be added per acre based on the P_1 test Broadcast		Through planter or drill
low	*med.*	*high*		for corn or soybeans		
20	10	7	69	or (a) 90 to 150	plus	20 to 40
25	15	10	83	(b)		40 to 60
30	20	15	90	60 to 120	or	30 to 40
38	30	20	97	60	or	20 to 30
45	40	30	98+	Phosphorus may be applied to maintain the soil test. Little or no response likely in the year of application.		
	all regions			for wheat and oats		
	10 to 15		Below 47	90 to 150	plus	30
					or	90
	20		57	60 to 120	plus	30
					or	80
	30		72	60 to 90	or	60
	40		82	60	or	30 to 60
	60		92			30

for alfalfa and alfalfa-grass mixtures before seeding when seeded alone

			broadcast seeding *expected yield per acre (tons)*		*band seeding* *expected yield per acre (tons)*	
low	*med.*	*high*	2-3	3-5	2-3	3-5
25	15	10	120	180	60	90
30	20	15	90	150	50	80
38	30	20	60	90	30	60
45	40	30	60	60	30	40
60	50	40	..	..	30	30

FIELD MAP OF P_1 TEST

The soil test will probably increase about 1 pound for every 9 pounds of P_2O_5 fertilizer (4 pounds P) applied. Rates of 120 and 150 pounds are for those who desire a rapid buildup in available phosphorus.

The highest drill rates are considered to be all that can be profitably placed in the band but they will have little effect on the soil test in following years and hence do not substitute for larger amounts broadcast for rapid buildup.

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INFORMATION TO HELP YOU PLAN A PHOSPHORUS PROGRAM

What Determines the Phosphorus-Supplying Power?

High phosphorus-supplying power means:

1. The amount of available phosphorus (P_1 test) in the subsoil is relatively high.

2. The conditions are favorable for good root penetration and branching in the subsoil.

Low phosphorus-supplying power may be caused by one or more of the following factors:

1. A low supply of available phosphorus in the subsoil because (a) the parent material was low in phosphorus; (b) phosphorus was lost in the soil-forming process; or (c) the phosphorus is made unavailable by high pH (calcareous) material.

2. Poor internal drainage that restricts root growth.

3. A dense, compact layer that inhibits root penetration or spreading.

4. Shallowness to bedrock, sand, or gravel.

5. Drouthiness, strong acidity, or other conditions that restrict crop growth and reduce rooting depth.

Suggested Annual Maintenance for Alfalfa, Grasses, and Alfalfa-Grass Mixtures

Phosphorus-supplying power rating of soil	Yield expected or obtained (tons dry matter per acre) 5	7	10
	Pounds P_2O_5 per acre		
Low	55	77	110
Low to medium	44	62	88
Medium	38	54	77
Medium to high	33	46	66
High to medium	28	38	55

Annual vs. Infrequent Applications

Applying phosphorus every 2 or 3 years (up to 4 years for alfalfa) is as effective as applying smaller amounts each year and it saves labor. Mixing the fertilizer into the soil by plowing, disking, or chiseling will reduce the likelihood of it being carried off the field through erosion. This may reduce excessive algae growth in lakes and reservoirs but it is probably not important in Illinois streams.

Illinois Tests for Phosphorus

Illinois laboratories make two tests for phosphorus, referred to as P_1 and P_2. The P_1 test (interpreted on the front of this sheet) measures readily available phosphorus. The P_2 test uses a stronger extractant and therefore measures both available phosphorus and phosphorus that has been built up with rock phosphate but has not yet been converted to available form. The P_1 test is a better indication of the soil phosphorus supply for this year's crop and also for the next year or two.

The P_2 test is used as a guide to the application of rock phosphate (see table at right). The results of this test are necessary for ACP practice payments.

If the P_2 test has been built to 50 or above through applications of soluble phosphates, the rating of the P_2 test in the table is too low and the suggested application is too high. A P_1 test is needed to show the status of available phosphorus.

Suggested Application of Rock Phosphate Based on the P_2 Soil Test

P_2 test	Rock phosphate for 8 to 10 years
	lb. per acre
Below 20	1,500
20 to 32	1,300
33 to 53	1,000
54 to 75	800
Above 75	No build-up application, but soluble phosphate is needed for wheat

Rock Phosphate or More Available Phosphate?

Rock phosphate contains about 30 percent total P_2O_5 of which about 1/10 is as available as that in other phosphorus-supplying fertilizers. The most economic use of rock phosphate is related to soil pH and to the amount of alfalfa or clover in the cropping system. **At pH 6.5 or above**, rock phosphate is not likely to be as economical as other sources. **At pH 6.0 to 6.5**, rock phosphate and more readily available forms may be equally profitable if (a) alfalfa, clover, lespedeza, or birdsfoot trefoil is an important part of the cropping system; (b) the soil is inherently moderately acid; and (c) ACP cost-sharing assistance is available. **Below pH 6.0**, there is enough soil acidity to efficiently release phosphorus from phosphate rock, so rock may be used in a soil-buildup program.

To Convert P_2O_5 Figures to Amount of P Contained

Phosphorus fertilizers are added in order to supply phosphorus. However, it has long been the custom to show percentages in terms of P_2O_5 content. To find the amount of P in P_2O_5, multiply the P_2O_5 figure by 0.44.

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. John B. Claar, *Director*, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

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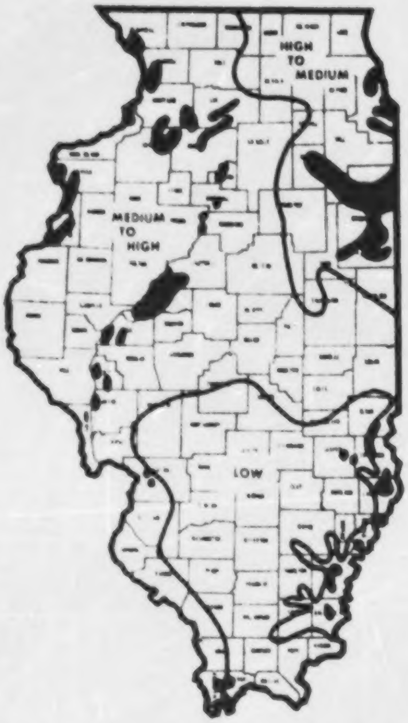
Urbana, Ill. 61801

Soil Test Form **D-4**

POTASSIUM (K) — MAPS AND INTERPRETATION

POTASSIUM-SUPPLYING POWER



STEPS TO FOLLOW

1. *Decide into which group your soil falls* with respect to potassium-supplying power. Illinois is divided into four general regions in terms of inherent potassium-supplying power. These regions are shown on the map of Illinois at left. There are, of course, important differences among the soils within these general regions because of the seven factors listed on the back of this sheet. Soils in the areas of the map shown in solid black are sands.

2. *Study the paragraph checked below* together with the field map of K test which shows the present potassium levels on your test field.

☐ Potassium is below the most profitable level. Potassium applications should therefore, be large enough to not only meet the needs of the next crop but also to raise the soil test level.

☐ Potassium is at the suggested level. You may broadcast potassium annually or at 2- to 3-year intervals to at least maintain the test level until the field is sampled again.

☐ Potassium is well above the level believed to be needed. Therefore no yield increase is likely from an application of potassium this year.

☐ Potassium is so high that you run the risk of creating problems with other nutrients, especially magnesium.

3. *Decide where and how to apply the needed potassium* by consulting the table below. The table is based on tests of samples taken between May 1 and September 30. Samples should never be taken when the soil is frozen. Seasonal adjustments for samples taken before April 30 and after October 1 are as follows: Dark-colored soils — subtract 30; light-colored soils in central and northern Illinois — subtract 45; low potassium-supplying soils south of Illinois Route 16 — subtract 60; fine-textured bottomland soils — subtract 45.

FIELD MAP OF K TEST

Soil test range	Estimated percent of maximum possible yield		Potassium rates to build soil test and to last 2 years (See back of sheet for 3rd and 4th years)			
			Soils LOW in potassium-supplying power		Soils MEDIUM to HIGH in potassium-supplying power	
	Corn, soybeans, alfalfa, clover	Wheat, oats	K_2O	K	K_2O	K
			lb.	*lb.*	*lb.*	*lb.*
90 or less	75 or less	90 or less	300	250	These soils are seldom this low	
91 to 120	76 to 81	91 to 94	270	225		
121 to 150	82 to 90	95 to 97	240	200	210	175
151 to 180	91 to 93	98 or more	210	175	180	150
181 to 210	94 to 95	98 or more	180	150	150	125
211 to 240	96 to 97	98 or more	150	125	120	100
241 to 300	98 or more	98 or more	120	100	See "When to Apply" on back of sheet	

Alfalfa or Alfalfa-Grass Seeding Without a Companion Crop (See Back of Sheet for Maintenance Rates)

K test level	Expected yield: seeding year if spring sown; following year if fall sown	
	2 to 3 tons	3 to 5 tons
	Pounds of K_2O to apply per acre	
90 or less	160	220
91 to 120	120	180
121 to 150	80	140
151 to 180	0	100
180 and above	0	0

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Vocational Agriculture Service · College of Agriculture · University of Illinois at Urbana-Champaign

Suggested Annual Potassium Maintenance Fertilization for Alfalfa, Grasses, and Alfalfa-Grass Mixtures After Soil Tests Are Built to High Levels

Nutrient-supplying power rating of soil (see map on front)	Percent of nutrients to be supplied by fertilization	Yield expected or obtained (tons dry matter per acre)		
		5	7	10
		Pounds K_2O per acre		
Low	100	250	350*	500*
Low to medium	80	225	315*	450*
Medium	70	200	280	400*
Medium to high	60	175	245	350*
High to medium	50	150	210	300
High	50	125	175	250

*Rates above 300 pounds K_2O should be split and applied at two different dates to prevent plant injury.

INFORMATION TO HELP YOU PLAN A POTASSIUM (K) PROGRAM

Why Soils Differ in Natural Supply of Potassium

Inherent potassium-supplying power depends mainly on:

1. The amount of clay and organic matter. This influences the exchange capacity of the soil.
2. The degree of weathering of the soil material. This affects the amount of potassium that has been leached out.
3. The kind of clay mineral.
4. Drainage and aeration. These influence the uptake of potassium.
5. pH. Very high calcium and magnesium reduce potassium uptake.
6. The parent material from which the soil formed.
7. Compactness or other conditions that influence root growth.

A soil test goal of 241 to 300 is suggested for all the regions. Rates of potassium suggested in the buildup period and for maintenance on soils that are classified low or medium in potassium-supplying power are larger than those for soils that are classified high.

Recent results show that a few soils respond to potassium applications even at tests above the suggested goal of 241 to 300. Research to identify these soils is continuing. They are likely to be fine-textured, very dark, and imperfectly drained.

Sandy soils are low in potassium-supplying power because they are low in exchange capacity and cannot hold much reserve K. In addition, minerals from which sandy soils develop are low in K.

The silt loams in the "low" area in southern Illinois (claypans) are relatively older soils in terms of soil development and consequently much more of the potassium has been leached out of the root zone. Furthermore, wetness and a platy structure in the upper subsoil may interfere with rooting and with K uptake early in the growing period even though roots are present.

Soils in northeastern Illinois that were formed from medium- to fine-textured till are quite high in potassium by soil test, but restricted drainage may reduce potassium uptake during the early part of the growing season. As a result, those soils with wetness problems have only a medium rating in their ability to supply potassium to crops.

When to Apply Potassium in the Cropping System

Corn, soybeans, and forage legumes are most sensitive to a potassium shortage. Applications should be timed to meet their needs.

On soils that have a very low potassium test, you may apply the suggested initial applications (even up to 300 pounds of K_2O per acre) at one time or you may apply 2/3 the first year and 1/3 the second year. For the third and fourth years, or until the field is resampled, the following approximate maintenance amounts are suggested: 60 pounds of K_2O per year or 120 pounds to last 2 years; double the amount on fields where silage or hay is removed and no manure returned.

There is no hard-and-fast rule for dividing the potassium over a 4-year cropping period. Broadcast applications every second or third year are as effective as smaller annual applications.

Safe Limits for Drill Applications

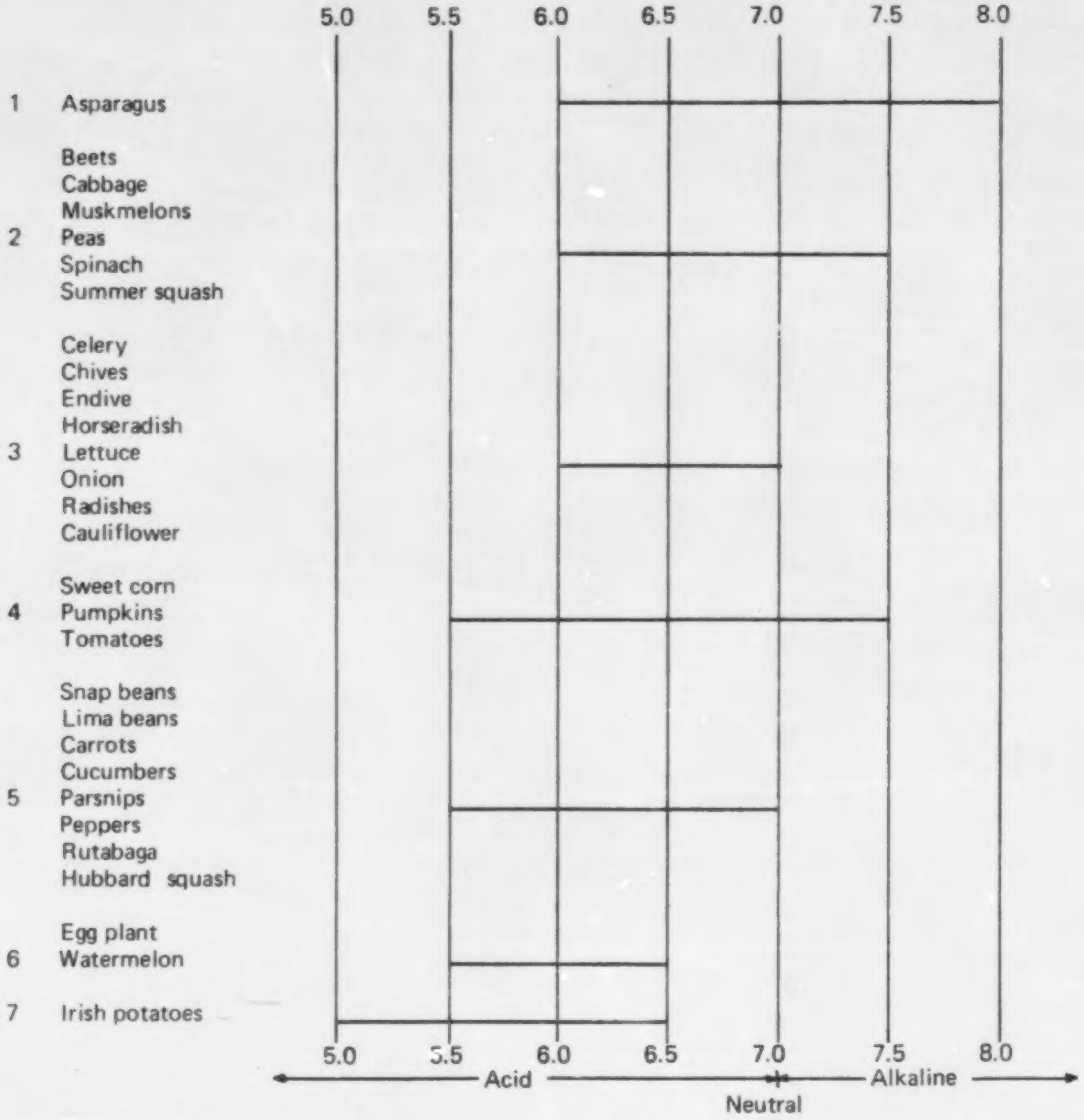
Since potassium salts are very soluble, large amounts cannot safely be placed near the seed. Nitrogen and potassium combined should not exceed about 40 pounds per acre for corn in 40-inch rows through a split boot. Larger amounts are safe through a planter with side placement of the fertilizer away from the seed. No more than 12 pounds should be applied as a pop-up fertilizer in contact with the seed.

Up to 40 pounds of K_2O (33 pounds of K) plus nitrogen is safe through the drill for small grain.

Soybeans are very sensitive to salt injury and no more than 40 pounds of K_2O (33 pounds of K) is suggested for side placement. Broadcast application of all potassium is preferred for soybean. Pop-up placement is discouraged.

INFORMATION SHEET

OPTIMUM pH FOR VEGETABLE CROPS



Note: Except in special cases the objective of a liming program for vegetable crops should be to keep the pH between 6 and 6.5, as this range is satisfactory for most vegetables.

Potatoes are sometimes grown in soil with a pH of 5 or lower in order to avoid serious damage from scab disease, which increases with increasing pH.

Cabbage plants are sometimes grown close to or about neutral in order to reduce damage from club root disease.

INFORMATION SHEET

SOIL TEST INTERPRETATION

		Fertility Requirement Groups*			
		I	II	III	IV
		Tomatoes Potatoes Peppers Egg plant Cabbage Cauliflower Broccoli Brussel sprouts Cucumbers Melons Squash Pumpkin	Asparagus Onions Sweet Corn Spinach Lettuce Sweet Potatoes Horseradish	Carrots Parsnips Beets Radishes Turnips	Beans Peas
P Soil Test**		P_2O_5 Requirement in pounds per acre			
P_1	P_2				
8	20	300	260	160	80
12	30	300	240	140	60
16	40	300	220	120	40
20	50	280	200	100	20
24	60	260	180	80	20
28	70	240	140	60	20
32	80	220	120	40	20
36	90	200	100	40	20
40	100	180	80	40	20
44	110	160	40	40	20
48	120	140	20	40	20
52	130	120	20	40	20
56	140	100	20	40	20
60	150	80	20	40	20
64	160	60	20	40	20
68	170	40	20	40	20
K Soil Test**		K_2O Requirement in pounds per acre			
40		260	260	200	80
60		240	240	180	60
80		220	220	160	40
100		200	200	140	20
120		200	200	120	40
140		180	180	100	20
160		160	160	100	20
180		140	140	100	20
200		120	120	100	20
220		120	120	100	20
240		100	100	100	20
260		80	80	100	20
280		80	60	100	20
300		80	40	100	20
320		80	20	100	20

* Home gardens may be treated as if all crops were in Group I.

** Soil tests by Illinois Soil Testing System.

LABORATORY EXERCISE

OBTAINING SOIL SAMPLES FROM LAWNS, GARDENS AND FLOWER BEDS

1. Obtain at least one composite sample for each soil difference. Differences can be due to texture, slope, color, drainage or past treatment. If a problem area is sampled keep it separate from the other composite samples.

2. For a composite samples obtain 10-15 samples from each area. Samples from individual beds should not be mixed. Take samples to a depth of 6 inches in flower beds and gardens and 4 inches in lawns.

3. Mix the soil for the composite sample and take out about 1 pint. Label each composite sample with a number and name. Keep a record of the area from which the samples came and fill out the information sheet "B" as completely as possible. Also include the following:

   a. The size of area (dimensions or number of square feet): ______________________________

   b. How many years has garden (or lawn or flowers) been in this spot? ______________________________

   c. Do you have manures, compost, leaves or other organic material available each year? (Yes or No) ____________ If so, how much? ______________________________

   d. What particular difficulties do you have with plant growth in this area? ______________________________

LABORATORY EXERCISE

SAMPLING GREENHOUSE SOILS

A. Stockpiles of Soil Mixes:

1. Take 10-15 samples from various locations in the stockpile and mix to obtain one composite sample.

2. Do not sample the surface. (Salt content may be higher due to evaporation.)

3. Sample to a depth of 10-12 inches.

B. Potted Crops:

1. 10-15 pots can be used to make a cross-section of a composite sample.

2. In large pots a probe can be used with minimum damage to the root system. On small pots the root ball will need to be removed from the pots and a sample of soil removed from the top to the bottom of the root ball where the roots are actively growing. The soil can be replaced by soil stock mix.

C. Take samples

D. Observations of results:

STUDENT WORKSHEET

SOIL SAMPLING

1. List four reasons for taking soil samples:
   a. ______
   b. ______
   c. ______
   d. ______

2. What does a soil test show?
   a. ______
   b. ______
   c. ______

3. What other techniques are used to evaluate fertilizer responses?
   a. ______ e. ______
   b. ______ f. ______
   c. ______ g. ______
   d. ______

4. What factors influence the number of samples taken from an area or field?
   a. ______
   b. ______
   c. ______
   d. ______
   e. ______

5. Describe some pitfalls to avoid in obtaining a good soil sample.
   a. ______
   b. ______
   c. ______
   d. ______
   e. ______
   f. ______
   g. ______

6. Describe the procedure to follow when collecting a soil sample.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

7. Why is information about past history included with the sample?

a. ____________________

____

____

b. ____________________

____

____

8. When and how often should a soil sample be taken?

a. ____________________

____

b. ____________________

____

c. ____________________

____

9. What soil testing services are locally available?

a. ____________________

b. ____________________

c. ____________________

10. What equipment is needed to take a soil sample?

a. ____________ c. ____________

b. ____________ d. ____________

TEACHER'S KEY
WORKSHEET 1

SOIL SAMPLING

1. List four reasons for taking soil samples:

   a. Makes more efficient use of resources.

   b. Maintain high fertility level.

   c. Avoid applying wrong elements.

   d. Rate is matched to crop yields.

2. What does a soil test show?

   a. pH level

   b. phosphorus level

   c. potassium level

3. What other techniques are used to evaluate fertilizer responses?

   a. Plant and tissue tests

   b. Observed deficiency symptoms

   c. Research data

   d. Demonstration plots

   e. Fertilization guides

   f. Knowledge of nutrient removal by crops

   g. Past crop responses to fertilizer

4. What factors influence the number of samples taken from an area or field?

   a. Slope, color, texture, structure of soils

   b. Erosion

   c. Past treatments

   d. Cropping system

   e. Land use history

5. Describe some pitfalls to avoid in obtaining a good soil sample.

   a. Don't mix different soil types

   b. Don't use dirty or oily tools

   c. Don't artifically dry samples

   d. Don't take sample from fertilizer band

   e. Don't take samples from fence rows, dead furrows, etc.

   f. Don't sample below plow depth

   g. Don't lose the map of sampling areas

6. Describe the procedure to follow when collecting a soil sample.

a. Use soil auger, soil tube, spade or trowel

b. Remove surface trash

c. Use center ½" of spade slice

d. Use recommended number of sampling areas

e. Sample to plow depth

f. Use clean containers

g. Mix thoroughly and place in marked bags.

7. Why is information about past history included with the sample?

a. Provides information about practices used which might influence fertility responses.

b. Former yield information and future goals are needed to provide an appropriate fertility recommendation.

8. When and how often should a soil sample be taken?

a. 4 – 6 years

b. Before tillage or soil treatments

c. In fall for spring planted crops and in summer for fall planted crops.

9. What soil testing services are locally available?

a. Illinois Soil Testing Laboratories

b. Farm Service Dealers

c. Other: schools and private institutions

10. What equipment is needed to take a soil sample?

a. Small sacks

b. Pan or bucket

c. Probe, auger, or spade or trowel

d. Box for carrying samples

LABORATORY EXERCISE

SOIL SAMPLING

I. OBJECTIVE:

Given a soil tube, auger or trowel, a clean pail, and a soil sampling information sheet, the student takes a soil sample, prepares it for mailing, and correctly fills out the information sheet.

II. INTRODUCTION:

Soil sampling is a standard procedure used by greenskeepers, landscape contractors, and nurserymen before planting an area with turfgrass or trees and shrubs. It is repeated annually in the maintenance of these plantings. Soil samples are usually taken in the fall.

The results of the soil test are returned to the sender, together with recommendations for the particular plant being grown. The recommendations should be carefully followed so that the right kinds and amounts of fertilizer are applied for good growth of the plants.

III. PROCEDURE:

1. Using a soil auger, trowel, or small spade, take thin slices of soil to a depth of 6 inches from 12 or more locations in the area to be planted, and place them in a clean pail.
2. If the area to be planted varies in kind of soil, previous crop, or previous fertilizer applications, make up a separate soil sample for each area.
3. Slice off the top 1/4 inch from each sample, and discard it.
4. Thoroughly mix the 12 or more samples from one area to make up a compost sample to be tested. Spead it on clean newspaper to dry overnight.
5. Fill out the soil sample information sheet for each composite sample and place it with the soil sample while it dries.
6. After the soil sample has dried overnight, place soil in the mailing container.
7. Fill out the address on the mailing container and attach the filled-out soil sample information sheet (be sure that the sheet goes with its matching soil sample). Complete Form "B" and mail it with the soil samples.

IV. OBSERVATIONS:

STUDENT WORKSHEET

SOIL pH

1) Name the three major elements necessary for plant growth.

2) Why do soils become acid or alkaline?

3) The most important single chemical characteristic of a soil is the degree of ________________ or ________________.

4) The soil reaction is indicated by ________________.

5) A soil with a pH of 6.0 is considered ________________ and alkaline soils have a pH greater than ________________.

6) The most desirable pH range for vegetable crops is ________________ to ________________.

7) List 3 vegetable crops that grow best in the following pH ranges:

pH	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.5
	a.	a.	a.	a.
	b.	b.	b.	b.
	c.	c.	c.	c.

8) The best way to keep check on soil acidity levels is by ________________.

9) List the three most commonly used liming materials for neutralizing soils.

a. ________________________

b. ________________________

c. ________________________

STUDENT WORKSHEET

PHOSPHORUS AND POTASSIUM

1) Name nine common sources of phosphorus and the approximate percentage of phosphorus.

	Name	%
a.	______________________	________
b.	______________________	________
c.	______________________	________
d.	______________________	________
e.	______________________	________
f.	______________________	________
g.	______________________	________
h.	______________________	________
i.	______________________	________

2) List six sources of potassium and their approximate percentage.

	Name	%
a.	______________________	________
b.	______________________	________
c.	______________________	________
d.	______________________	________
e.	______________________	________
f.	______________________	________

3) The three forms of potassium in soil are:

a. ______________________

b. ______________________

c. ______________________

4) What effect does pH have on the availability of phosphorus and potassium?

5) A survey of fields in Illinois showed about 16% were unrealistically high in their p_1 test. What are some possible explanations for these results?

6) What is the phosphorus supplying power of the soil in your region of Illinois?

6) What is the phosphorus supplying power of the soil in your region of Illinois?

7) To increase the P_1 test one pound, you must apply ________ pounds of P_2O_5 per acre.

8) What is the potassium supplying power of the soil in your region of Illinois?

9) To increase the soil potassium test one pound, you must apply how many pounds of K_2O?

TEACHER'S KEY
WORKSHEET 1

SOIL pH

1. Name the three major elements necessary for plant growth.

   a. Nitrogen

   b. Phosphorus

   c. Potassium

2. Why do soils become acid or alkaline?

   Fluctuations in hydrogen ions in the soil.

3. The most important single chemical characteritic of a soil is the degree of acidity or alkalinity.

4. The soil reaction is indicated by pH scale.

5. A soil with a pH of 6.0 is considered acid and alkaline soils have a pH great than 7.0.

6. The most desirable pH range for vegetable crops is 6.0 to 7.0.

7. List four crops that grow best in the following pH ranges: (Refer to Transparency 33)

pH 5.0–5.5	5.5–6.0	6.0–6.5	6.5–7.5
a.	a.	a.	a.
b.	b.	b.	b.
c.	c.	c.	c.
d.	d.	d.	d.

8. The best way to keep check on soil acidity levels is by soil testing.

9. List the three most commonly used liming materials for neutralizing soils.

   a. Limestone–Ag. Lime

   b. Superphosphate

   c. Calcium Nitrate

   Calcium sulfate, Calcium cyanamid

TEACHER'S KEY
WORKSHEET 2

PHOSPHORUS AND POTASSIUM

1. Name nine common sources of phosphorus and the approximate percentage of phosphorus.

	Name	%
a.	Superphosphate	16–22
b.	Triple superphosphate	42–50
c.	Liquid phosphoric acid	54
d.	Nitric phosphate	10–22
e.	Colloidal phosphate	20
f.	Basic slag	8–12
g.	Ammonium phosphate	20–39
h.	Monophosphate	48
i.	Diammonium phosphate	48–53

2. List six sources of potassium and their approximate percentage.

	Name	%
a.	Potassium chloride (nuriate)	60
b.	Potassium sulfate	50
c.	Potassium nitrate	44
d.	Potassium-magnesium sulfate	22
e.	Potassium-sodium nitrate	14
f.	Potassium phosphate	48

3. The three forms of potassium in soil are:

a. Soil solution

b. Exchangeable K

c. Storehouse form

4. What affect does pH have on the availability of phosphorus and potassium?

Acid and alkaline conditions limit phosphorus.

acid conditions limit potassium.

5. A survey of fields in Illinois showed about 16% were unrealistically high in their P_1 test. What are some possible explanations for these results?

Poor sampling procedures

Improper fertilizer applications

May represent only a small area in the field.

6. What is the phosphorus supplying power of the soil in your region of Illinois?

7. To increase the P_1 test one pound, you must apply 9 pounds of P_2O_5 per acre.

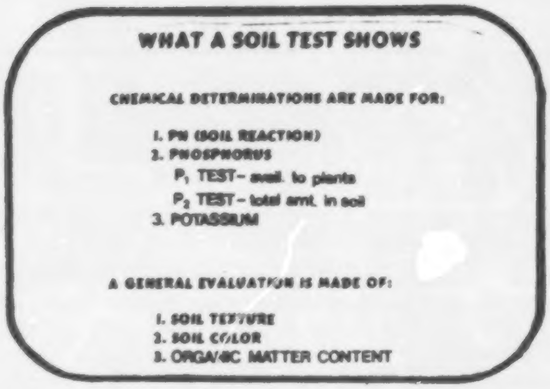
8. What is the potassium supplying power of the soil in your region of Illinois?

9. To increase the soil potassium test one pound, you must apply how many pounds of K_2O?

4

TRANSPARENCY DISCUSSION GUIDE

SOIL TESTING AND [illegible]Y



WHAT A SOIL TEST SHOWS

CHEMICAL DETERMINATIONS ARE MADE FOR:

1. PH (SOIL REACTION)
2. PHOSPHORUS
   - P_1 TEST– avail. to plants
   - P_2 TEST– total amt. in soil
3. POTASSIUM

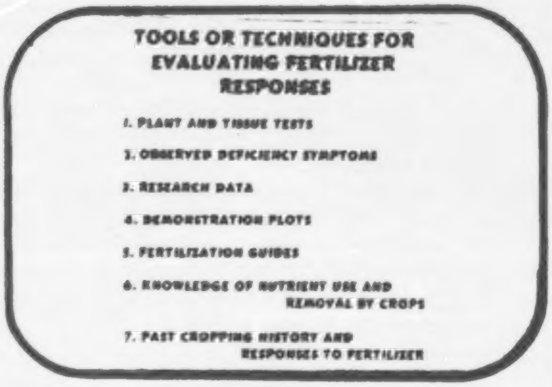
A GENERAL EVALUATION IS MADE OF:

1. SOIL TEXTURE
2. SOIL COLOR
3. ORGANIC MATTER CONTENT

1. A soil test is a chemical test to determine the amounts of various plant nutrients present in the soil in forms that are available to plants. Soil testing can be done in a laboratory, or with soil test kits in the field. Each type of soil test has its advantages and disadvantages.

   a. The soil test kits, commonly called "quick, rapid, or indicator" tests, are faster; and the testing can be done in the field in a few minutes. These tests; however, are not as accurate as a laboratory soil test.

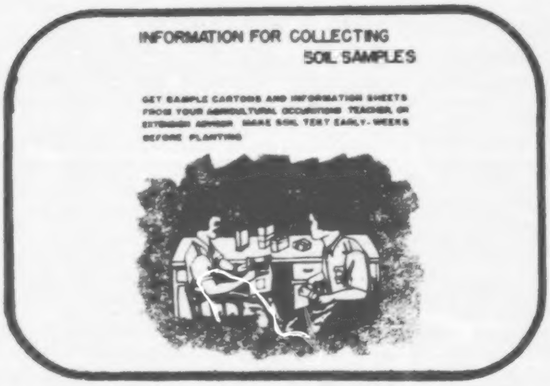
   b. The laboratory soil test takes more time because it is more precise. Representative good samples are essential to reliable soil tests.



TOOLS OR TECHNIQUES FOR EVALUATING FERTILIZER RESPONSES

1. PLANT AND TISSUE TESTS
2. OBSERVED DEFICIENCY SYMPTOMS
3. RESEARCH DATA
4. DEMONSTRATION PLOTS
5. FERTILIZATION GUIDES
6. KNOWLEDGE OF NUTRIENT USE AND REMOVAL BY CROPS
7. PAST CROPPING HISTORY AND RESPONSES TO FERTILIZER

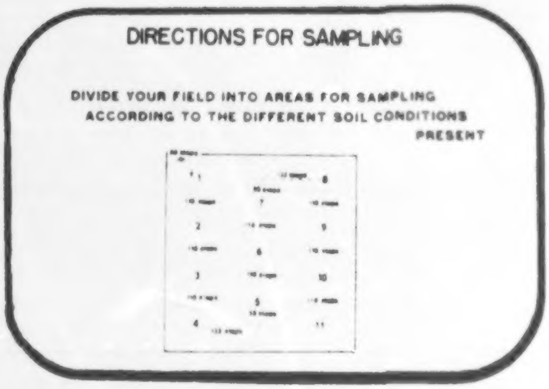
2. In addition to the experience of a farmer, there are a number of other tools or techniques available for determining nutrient requirements. These are listed on the transparency and the advantages and disadvantages of each can be discussed.



INFORMATION FOR COLLECTING SOIL SAMPLES

GET SAMPLE CARTONS AND INFORMATION SHEETS FROM YOUR AGRICULTURAL OCCUPATIONS TEACHER, OR EXTENSION ADVISOR. MAKE SOIL TEST EARLY- WEEKS BEFORE PLANTING

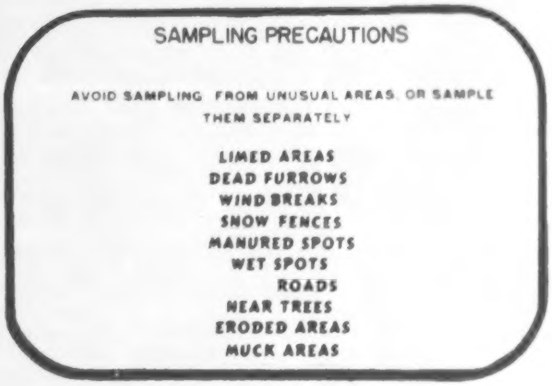
3. An important item that must accompany the soil sample is the information sheet. This sheet, properly completed, aids in the interpretation of the soil test and in making fertilizer recommendations. The sheet should be completed and sent with the soil samples. The time spent giving specific answers is well spent.



DIRECTIONS FOR SAMPLING

DIVIDE YOUR FIELD INTO AREAS FOR SAMPLING ACCORDING TO THE DIFFERENT SOIL CONDITIONS PRESENT

4. For fields that appear to have only one kind of soil or that have been cropped, fertilized, or limed the same, you may collect samples as shown by the diagram on the transparency. If there are soil difference or problem areas, you may want to also sample these areas. A few extra samples take little time or money but may give a much better picture of the fertility status of the fields. Fields are sampled only once in 4 to 8 years.

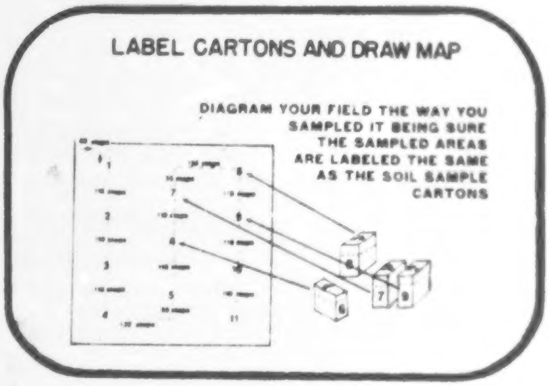


SAMPLING PRECAUTIONS

AVOID SAMPLING FROM UNUSUAL AREAS OR SAMPLE THEM SEPARATELY

LIMED AREAS
DEAD FURROWS
WIND BREAKS
SNOW FENCES
MANURED SPOTS
WET SPOTS
ROADS
NEAR TREES
ERODED AREAS
MUCK AREAS

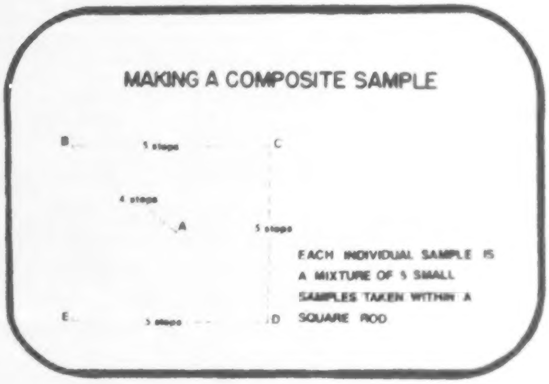
5. Over a period of years, a farmer is likely to invest several thousand dollars on the basis of results obtained from soil tests in a 40-acre field. It is easily possible to make hundreds of dollars for an extra hour spent in careful sampling and recording the location of each sample. Avoid areas that are not representative or that will give inaccurate results. The best laboratory test in the world made on samples that are carelessly taken are not only worthless but may lead you to spend thousands of dollars for plant nutrients that you do not need while you neglect to buy nutrients that your fields lack.



LABEL CARTONS AND DRAW MAP

DIAGRAM YOUR FIELD THE WAY YOU SAMPLED IT BEING SURE THE SAMPLED AREAS ARE LABELED THE SAME AS THE SOIL SAMPLE CARTONS

6. Take the samples and record the location of each and outline low spots, knolls, draws, etc., on the map. This information is needed to help you or the person who interprets the test to arrive at the proper treatment. If you plan to treat according to soil tests, then you must know where each sample came from.

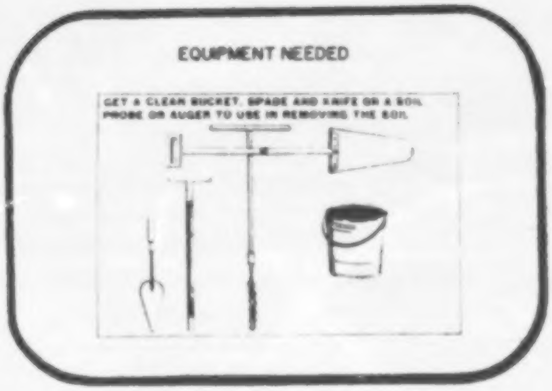


MAKING A COMPOSITE SAMPLE

EACH INDIVIDUAL SAMPLE IS A MIXTURE OF 5 SMALL SAMPLES TAKEN WITHIN A SQUARE ROD

7. The reason for taking these five small samples is to make certain that the whole sample does not come from within a band of fertilizer applied in a previous year.

Eleven samples are suggested for a 40-acre field, seven for 20 acres, and four for 10 acres. This number is needed in order to outline areas with different fertility status or to unseen soil differences in previous fertilizer or limestone applications or cropping systems.

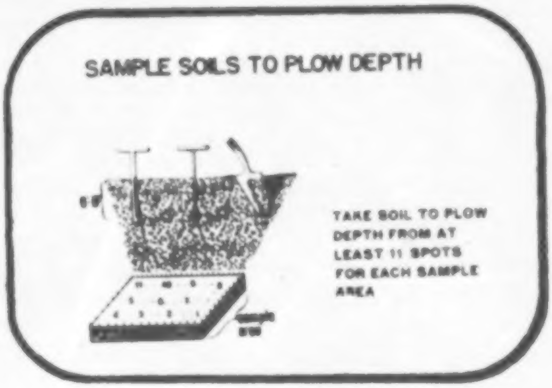


EQUIPMENT NEEDED

GET A CLEAN BUCKET, SPADE AND KNIFE OR A SOIL PROBE OR AUGER TO USE IN REMOVING THE SOIL

8.

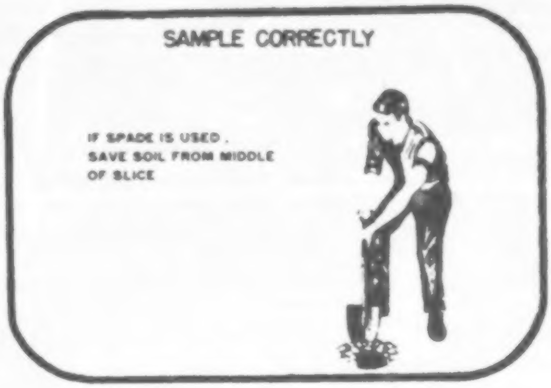
A supply of at least 11 small paper sacks, cartons, or bags (for a 40-acre field)
A basket or box for carrying the samples.
A pan or bucket for mixing the small samples.
A trowel, spade, or auger to dig the samples.



SAMPLE SOILS TO PLOW DEPTH

TAKE SOIL TO PLOW DEPTH FROM AT LEAST 11 SPOTS FOR EACH SAMPLE AREA

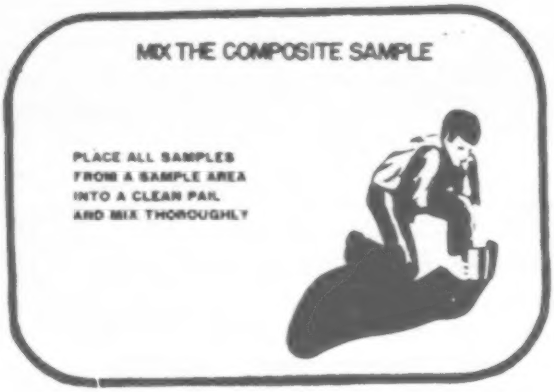
9. Because of large tractors and equipment, many farmers are plowing deeper--about 9 inches. For each inch less, the limestone requirement may be reduced by 10 percent.



SAMPLE CORRECTLY

IF SPADE IS USED, SAVE SOIL FROM MIDDLE OF SLICE

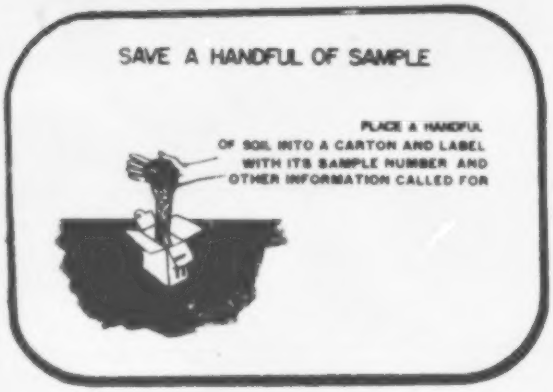
10. If a spade is used, save the soil from the middle of the slice. This will be a more representative sample, like plow depth, than soil taken at the side. A hunting knife is very helpful to make the center cut.



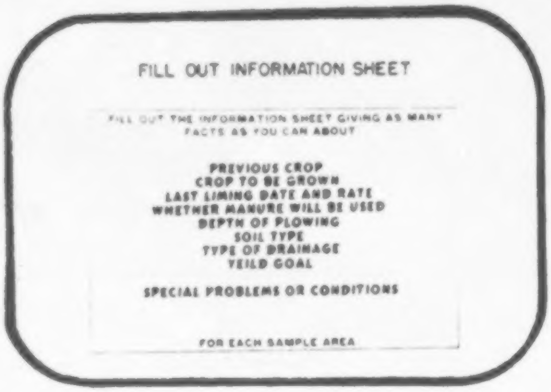
MIX THE COMPOSITE SAMPLE

PLACE ALL SAMPLES FROM A SAMPLE AREA INTO A CLEAN PAIL AND MIX THOROUGHLY

11. Mix the composite sample thoroughly and place a handful in properly marked container. Discard remaining composite sample.


SAVE A HANDFUL OF SAMPLE
PLACE A HANDFUL OF SOIL INTO A CARTON AND LABEL WITH ITS SAMPLE NUMBER AND OTHER INFORMATION CALLED FOR

12. Be sure to label sample and save a handful of soil.


FILL OUT INFORMATION SHEET

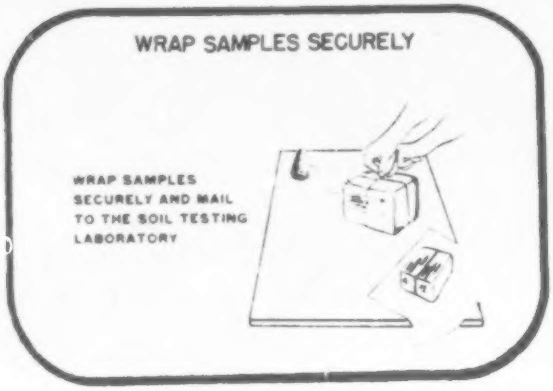
FILL OUT THE INFORMATION SHEET GIVING AS MANY FACTS AS YOU CAN ABOUT

PREVIOUS CROP
CROP TO BE GROWN
LAST LIMING DATE AND RATE
WHETHER MANURE WILL BE USED
DEPTH OF PLOWING
SOIL TYPE
TYPE OF DRAINAGE
YEILD GOAL

SPECIAL PROBLEMS OR CONDITIONS

FOR EACH SAMPLE AREA

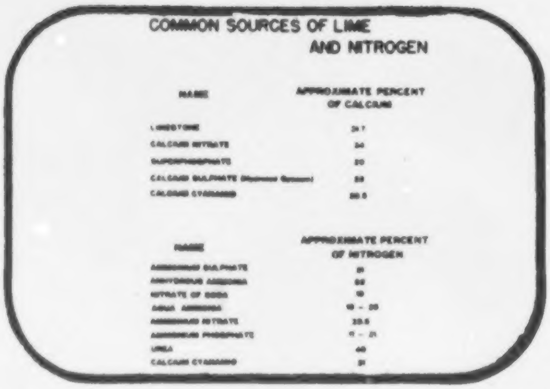
13. Fill out Soil Test Form B. This form lists the cropping history, previous fertilizer, lime, and manure treatments, and other information to supplement the information supplied by the soil tests and thus lead to more sound fertility suggestions. The soil test is an important tool in diagnosing fertility needs and in suggesting treatments, but it should never be the only tool. Here is an illustration to prove the point. If you apply limestone according to the results of a soil test and then retest within two years, the second test will show a considerable limestone requirement even though there is enough in the soil for high yields of legumes. The soil test by itself in this case is misleading.


WRAP SAMPLES SECURELY
WRAP SAMPLES SECURELY AND MAIL TO THE SOIL TESTING LABORATORY

14. Mail or take samples to the laboratory. The samples will be air-dried for several days at the laboratory before tested. Do not place samples on a stove or radiator for quick drying. This will produce misleading test results.

TRANSPARENCY STUDY GUIDE

SOIL TEST INTERPRETATION



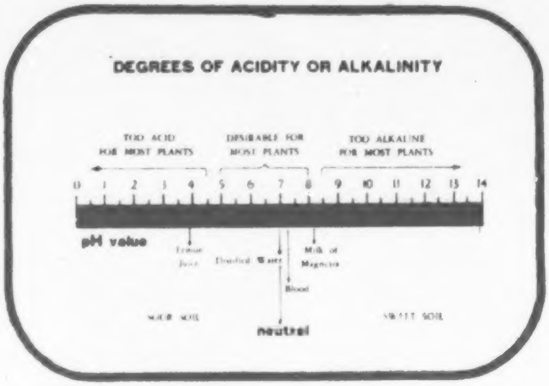
COMMON SOURCES OF LIME AND NITROGEN

NAME — APPROXIMATE PERCENT OF CALCIUM

NAME — APPROXIMATE PERCENT OF NITROGEN

1. Some of the main factors to consider in selecting liming materials are neutralizing power, fineness, and price.

When deciding on which source of nitrogen fertilizer to buy, be sure to consider the following factors: (1) the availability of nutrients contained in the different fertilizer materials; (2) the comparative cost per pound of available nutrients; (3) the effect of the fertilizer materials upon soil reaction--pH value, etc.; and (4) the physical nature of the fertilizer material as it relates to the method and ease of application. Perhaps the most important point to keep in mind in our present price squeeze is the cost per pound of nitrogen from each of the various sources. Pound per pound, available nitrogen supplied by one carrier, or form, is about as effective as that supplied by another.

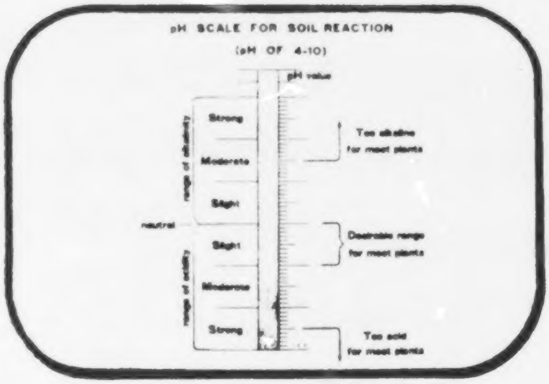

DEGREES OF ACIDITY OR ALKALINITY
TOO ACID FOR MOST PLANTS
DESIRABLE FOR MOST PLANTS
TOO ALKALINE FOR MOST PLANTS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
pH value
Lemon Juice
Distilled Water
Milk of Magnesia
Blood
SOUR SOIL
SWEET SOIL
neutral

2. This transparency relates pH to some common terms. Note the pH of lemon juice, blood, and milk of magnesia on the scale and the general pH range for most crops. pH values above 8.5 are too alkaline for most plants, and pH values below 5 are too acidic for most plants. Alkaline soils have pH's above 7.. Acidic soils have a pH below 7.

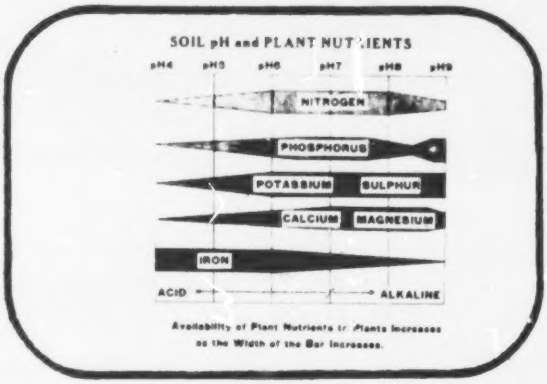
To become better acquainted with pH, the taste of the following items can be considered:

The lemon juice put in iced tea is acidic--it has a "sour" taste. Lemon juice has a pH of about 4. Acid soils are sometimes called "sour". Persons having a tooth pulled, or a cut in their mouth, recall that blood has a salty taste. The pH of blood is a little over 7, so that it is slightly alkaline. The milk of magnesia taken for an upset stomach has a pH of about 8, so that it is more alkaline (basic) than blood, and it tastes "sweeter" than lemon juice. Alkaline soils are sometimes called "sweet". Most agronomists, however, prefer to use the terms "acidic" or "alkaline" rather than "sour" and "sweet".

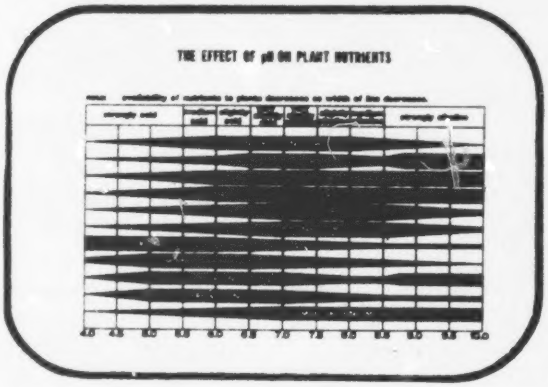
Examples of the extreme ranges of the pH scale would be as follows: The pH of most common dry drain cleaners is around 12. These products are alkaline. The battery acid in a car battery has a pH value of about 2. Battery acid is obviously acidic. The distilled or "bottled" water for sale in stores is neutral--that is it is neither acidic nor alkaline--this water has a pH of 7.


pH SCALE FOR SOIL REACTION
(pH OF 4-10)
pH value
range of alkalinity
Strong
Moderate
Slight
neutral
Slight
Moderate
Strong
range of acidity
Too alkaline for most plants
Desirable range for most plants
Too acid for most plants

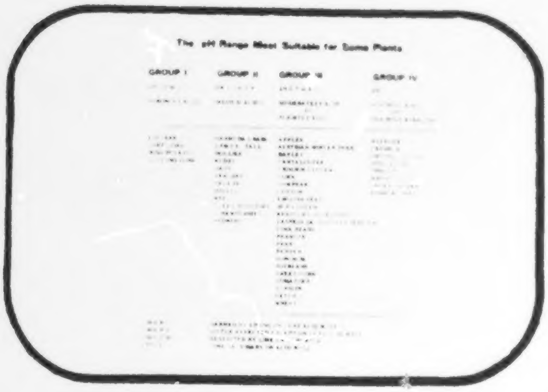
3. The most desirable pH range for farm crops is 6.0 - 7.0. Different kinds of plants, however, grow on soils with different pH values. For example, alfalfa does best on soils slightly acid to slightly alkaline; whereas, potato will grow on strongly acid soils.



4. The availability of essential plant nutrients is related to pH. Note the difference in the availability of iron and calcium as pH changes.



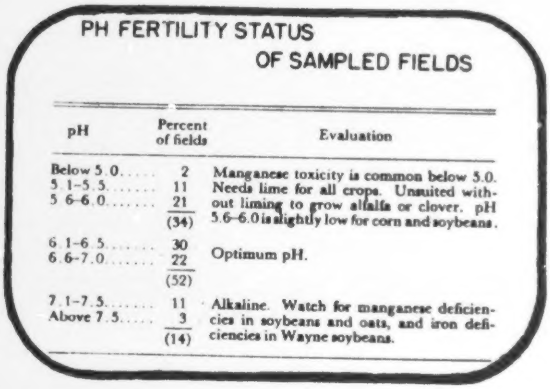
5. This transparency illustrates nutrient availability as influenced by pH. As the width of the nutrient line decreases, the availability of the nutrient decreases. Note how potassium is practically non-available at pH 4.5, but is little affected from pH 7-10. Notice how pH affects the availability of nitrogen, phosphorus, iron, and zinc in the soil pH range of 5-8.5. Acidic conditions limit or decrease the availability of nitrogen and phosphorus. Iron and zinc are little affected under slightly acidic conditions. However, notice the decreased availability of iron and zinc in the alkaline pH range of 7-8.5.



The pH Range Most Suitable for Some Plants

GROUP I	GROUP II	GROUP III	GROUP IV
[illegible]	[illegible]	[illegible]	[illegible]

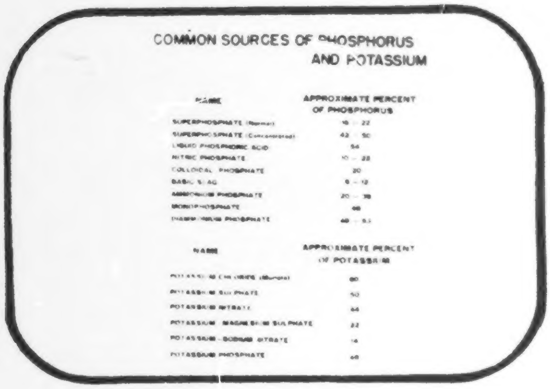
6. Different kinds of plants have the ability to grow and produce on soils with different soils pH values. Some grow only in acid soils, while most crop plants do best on moderately to slightly acid soils. Other plants grow better on slightly acid to slightly alkaline soils.



PH FERTILITY STATUS OF SAMPLED FIELDS

pH	Percent of fields	Evaluation
Below 5.0	2	Manganese toxicity is common below 5.0. Needs lime for all crops. Unsuited without liming to grow alfalfa or clover. pH 5.6–6.0 is slightly low for corn and soybeans.
5.1–5.5	11	
5.6–6.0	21	
	(34)	
6.1–6.5	30	Optimum pH.
6.6–7.0	22	
	(52)	
7.1–7.5	11	Alkaline. Watch for manganese deficiencies in soybeans and oats, and iron deficiencies in Wayne soybeans.
Above 7.5	3	
	(14)	

7. A 3-year survey of 1,706 fields in corn and soybeans in 74 counties was conducted by the University of Illinois Agronomy Department. The results are shown in this transparency and indicates that many liming programs are being short-changed on a growing number of Illinois farms. The use of nitrogen fertilizer has rapidly increased, but the tonnage of limestone has not kept pace. It requires about four pounds of lime to neutralize the acidity of one pound of nitrogen applied as ammonia or urea and as much as nine pounds of lime to neutralize the acidity resulting from one pound of nitrogen as ammonium sulfate. A soil test every four years is the best way to keep check on soil acidity levels.



COMMON SOURCES OF PHOSPHORUS AND POTASSIUM

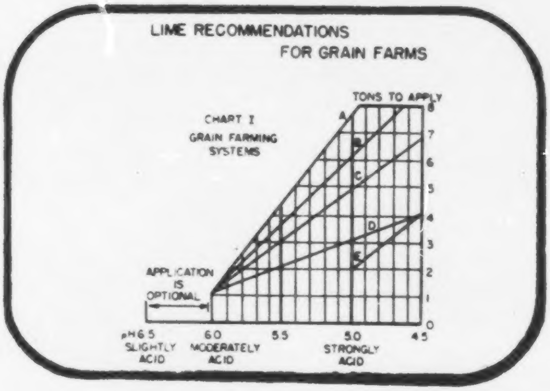
NAME	APPROXIMATE PERCENT OF PHOSPHORUS
SUPERPHOSPHATE (Normal)	16 – 22
SUPERPHOSPHATE (Concentrated)	42 – 50
LIQUID PHOSPHORIC ACID	54
NITRIC PHOSPHATE	10 – 22
COLLOIDAL PHOSPHATE	20
BASIC SLAG	8 – 12
AMMONIUM PHOSPHATE	20 – [illegible]
[illegible]	48
[illegible] PHOSPHATE	40 – [illegible]

NAME	APPROXIMATE PERCENT OF POTASSIUM
POTASSIUM CHLORIDE (Muriate)	60
POTASSIUM SULPHATE	50
POTASSIUM NITRATE	44
POTASSIUM - MAGNESIUM SULPHATE	22
POTASSIUM - SODIUM NITRATE	14
POTASSIUM PHOSPHATE	[illegible]

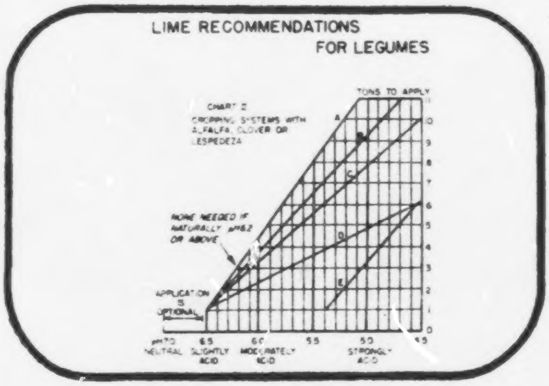
8. The availability of inorganic phosphorus is largely determined by the following factors: (1) soil pH; (2) soluble iron, aluminum, and manganese; (3) presence of iron--, aluminum--, and manganese--containing minerals; (4) available calcium and calcium minerals; (5) amount and decomposition of organic matter; and (6) activities of microorganisms. The first four of these factors are interrelated because their effects are largely dependent upon soil pH.

The general trend by farmers is to use a soluble form of phosphorus fertilizers. Rock phosphate, which was earlier used, is not likely to be as economical as other sources at soil pH 6.0 and above. The amount of alfalfa or clover in the cropping system may also affect this decision; but most farmers prefer fertilizer that is more readily available to plants.

Potassium occurs in the soil in three main forms: (1) in the soil solution, (2) as exchangeable K, and (3) in the storehouse form. The K in the soil solution is used by plants. The exchangeable K is held on the outside of the clay minerals and the soil humus; the storehouse form of K is held in the interior of the clay. As K in the soil solution is used by plants, the exchangeable K on the clay easily goes into the solution and, in turn, the K from inside the clay (storehouse form) slowly moves to the outside of the clay thus becoming exchangeable. During the time of the year when crops are not growing, K continues to move from the storehouse to build up the supply of exchangeable and soil solution K.

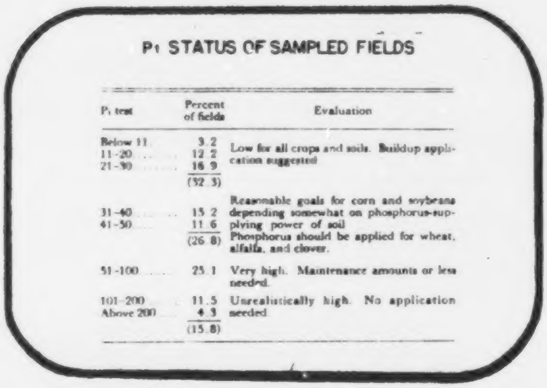


9\.
1. Use Chart I for a grain farming system.
2. Decide which soil class fits your soil--
   - A. Silty clays and silty clay loams (dark).
   - B. Silty clays and silty clay loams (light and medium). Silt and clay loams (dark).
   - C. Silt and clay loams (light and medium), sandy loams (dark), loams (dark and medium).
   - D. Loams (light), sandy loams (light and medium), sands.
   - E. Muck and peat.
3. Find your soil's pH along the bottom of the chart.
4. Follow up the vertical line until it intersects the diagonal line A, B, C, D, or E that fits your soil.
5. Read the suggested rate of application along the right side of the chart that you are using.



10\.
1. Use Chart II for a cropping system with alfalfa, clover, or lespedeza.
2. Decide which soil class fits your soil--
   - A. Silty clays and silty clay loams (dark).
   - B. Silty clays and silty clay loams (light and medium). Silt and clay loams (dark).
   - C. Silt and clay loams (light and medium), sandy loams (dark), loams (dark and medium).
   - D. Loams (light), sandy loams (light and medium), sands.
   - E. Muck and peat.

c. Find your soil's pH along the bottom of the chart.
d. Follow up the vertical line until it intersects the diagonal line A, B, C. D, or E that fits your soil.
e. Read the suggested rate of application along the right side of the chart that you are using.

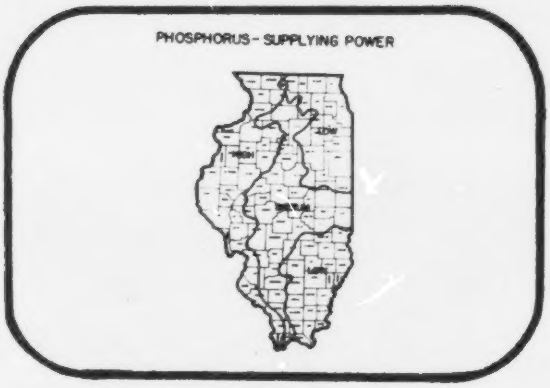


P_1 STATUS OF SAMPLED FIELDS

P_1 test	Percent of fields	Evaluation
Below 11	3.2	Low for all crops and soils. Buildup application suggested
11-20	12.2	
21-30	16.9	
	(32.3)	
31-40	15.2	Reasonable goals for corn and soybeans depending somewhat on phosphorus-supplying power of soil
41-50	11.6	
	(26.8)	Phosphorus should be applied for wheat, alfalfa, and clover.
51-100	25.1	Very high. Maintenance amounts or less needed.
101-200	11.5	Unrealistically high. No application needed.
Above 200	4.3	
	(15.8)	

11. A 3-year survey of 1,706 fields in corn and soybeans in 74 counties showed the following phosphorus fertility status. It was conducted by the University of Illinois Agronomy Department.

About one-third of the fields (32.3 percent) are definitely low in available phosphorus, over one-fourth (26.8 percent) are near suggested levels, 40.9 percent are above suggested levels and, of those, 15.8 percent are unrealistically high. Some of the very high tests may represent only the small area in the field that was sampled rather than the entire field. Extremely high tests may be caused by an old manure pile or burning of brush or corncobs.



PHOSPHORUS-SUPPLYING POWER

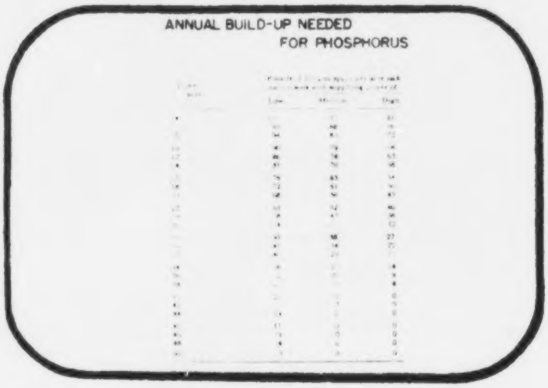
12. Illinois has been divided into four regions in terms of inherent phosphorus-supplying power of the soil below the plow layer in dominant soil types.

High phosphorus-supplying power means:

a. The amount of available phosphorus (P$_1$ test) in the subsoil is relatively high.
b. The conditions are favorable for good root penetration and branching in the subsoil.

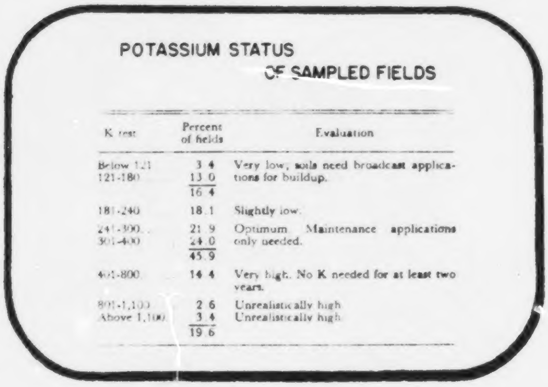
Low phosphorus-supply power may be caused by one or more of the following factors:

a. A low supply of available phosphorus in the subsoil because (1) the parent material was low in phosphorus; (2) phosphorus was lost in the soil-forming process; or (3) the phosphorus is made unavailable by high pH (calcareous) material.
b. Poor internal drainage that restricts root growth.
c. A dense, compact layer that inhibits root penetration or spreading.
d. Shallowness to bedrock, sand, or gravel.
e. Drouthiness, strong acidity, or other conditions that restrict crop growth and reduce rooting depth.



ANNUAL BUILD-UP NEEDED FOR PHOSPHORUS

13. Research has shown that it requires, as an average for Illinois soils, nine pounds of P_2O_5 per acre to increase the P_1 soil test one pound. Therefore, the recommended rate of build-up phosphorus is equal to: the soil test goal minus the actual soil test value multiplied by nine. The amount of phosphorus is equal to: the soil test goal minus the actual soil test value multiplied by nine. The amount of phosphorus recommended for build-up over a four-year period for various soil test levels is shown in this transparency.



POTASSIUM STATUS OF SAMPLED FIELDS

K test	Percent of fields	Evaluation
Below 121	3.4	Very low, soils need broadcast applications for buildup.
121-180	13.0	
	16.4	
181-240	18.1	Slightly low.
241-300	21.9	Optimum. Maintenance applications only needed.
301-400	24.0	
	45.9	
401-800	14.4	Very high. No K needed for at least two years.
801-1,100	2.6	Unrealistically high
Above 1,100	3.4	Unrealistically high
	19.6	

14. A 3-year survey of 1,706 fields in corn and soybeans in 74 counties showed the following potassium fertility status. It was conducted by the University of Illinois Agronomy Department.

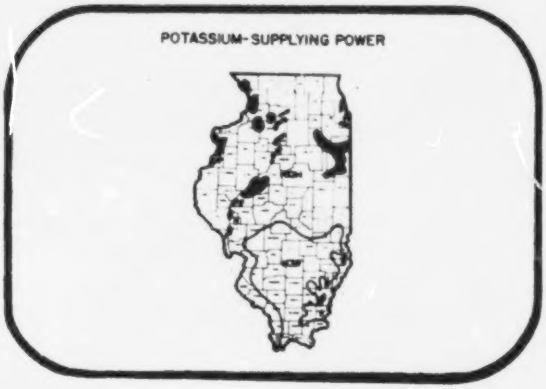
About 16.4 percent of the fields are low to very low in potassium for all crops, 18.1 percent slightly low, and 19.6 percent are unnecessarily high. Some of the highest test results for potassium may have been found on small areas where some residue had been burned.

Research at a few locations shows responses of corn to potassium at soil tests above 241. At present fertilizer prices farmers may choose to aim for a test of 300 rather than 241.

15. Illinois is divided into four general regions based on potassium-supplying power. There are, of course, important differences among soils within these general regions because of differences in the seven factors listed below:

Inherent potassium-supplying power depends mainly on:

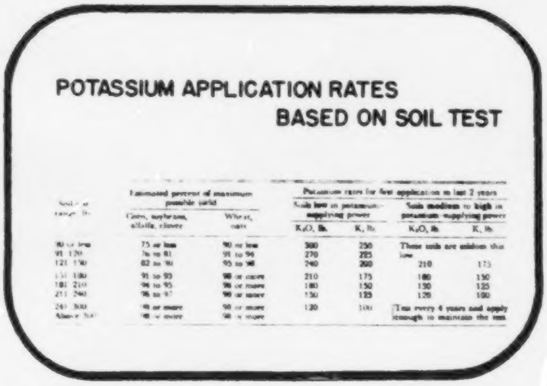
a. The amount of clay and organic matter. This influences the exchange capacity of the soil.
b. The degree of weathering of the soil material. This affects the amount of potassium that has been leached out.
c. The kind of clay mineral.
d. Drainage and aeration. These influence the uptake of potassium.
e. pH. Very high calcium and magnesium reduce potassium uptake.
f. The parent material from which the soil formed.
g. Compactness or other conditions that influence root growth.

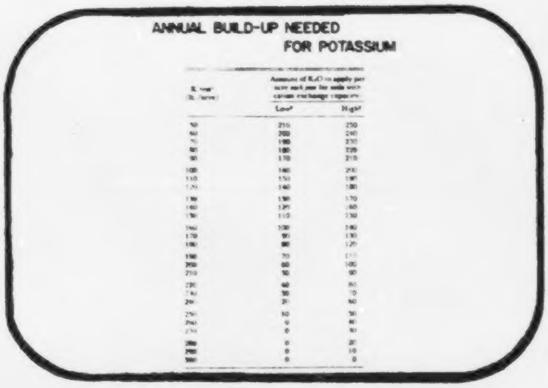

POTASSIUM-SUPPLYING POWER

16. Decide where and how to apply the needed potassium by using your soil test range and crop being grown. This table is based on tests of samples taken between May 1 and September 30.

NOTE: Samples should never be taken when the soil is frozen. Soil tests are most reliable when taken during the growing season. Seasonal adjustments for samples taken before April 30 and after October 1 are as follows:

Dark-colored soils--subtract 30.
Light-colored soils in central and northern Illinois--subtract 45.
Low potassium-supplying soils south of Illinois Route 16--subtract 60.
Fine-textured bottomland soils--subtract 45.


POTASSIUM APPLICATION RATES BASED ON SOIL TEST


ANNUAL BUILD-UP NEEDED FOR POTASSIUM

17. Research has shown that it requires on the average four pounds of K_2O to increase the soil test one pound. Therefore, the recommended rate of potassium application for increasing the soil test value to the desired goal is equal to: soil test goal minus the actual soil test value multiplied by four.

SAMPLE TEST QUESTIONS AND TEACHERS KEY

1. Explain in writing two reasons for testing soil.

   a. more efficient use of resources

   b. maintain high fertility

   Others: avoid applying the wrong elements

   match the rate to the expected yield

2. Select from the list below, three major items for which soils are tested. Underline the correct answers.

   a. Nitrogen
   b. Calcium
   c. PH
   d. Zinc
   e. Manganese
   f. Phosphorus
   g. Iron
   h. Potassium

3. Name four techniques, other than soil sampling, which are used to evaluate fertilizer responses.

   a. plant tissue test

   b. observed deficiency symptoms

   c. research data

   d. demonstration plots

   Others: Fertilization Guide Knowledge of Fertility Removal Past responses to fertilizers

4. Place an "X" in the blank to select the correct procedure to follow for collecting a representative soil sample.

   _____ a. Ten samples should be taken in each area.

   _____ b. Samples should be taken from soil below eight inches in the lawn on vegetable garden.

   _____ c. Approximately one quart of mixed soil should be placed in a suitable container for sending to a soil testing laboratory.

   __X__ d. Take the samples and record the location of each and outline low spots, knolls, draws, etc. on a map.

5. Select from list below, areas from which samples should not be taken. Underline the unsuitable sites.

   a. fence rows
   b. wet spots
   c. acid soils
   d. manured spots
   e. windbreaks
   f. roads and lanes

6. Name two items of information that should be subitted on the information sheet with the soil samples.

   a. previous crop

   b. crop to be grown

   Others: Special problems
   last liming and date
   soil type if manure
   has been used

7. Why is it not necessary to analyze soil every year?

   It takes a period of years for the soil fertility levels to adjust. There is no notable yearly changes. Note: This may not be true of artifcial soil medias.

8. Why is proper identification of the soil samples important?

   Different fertilizer rates may be recommended for different samples.

9. Identify four sampling tools.

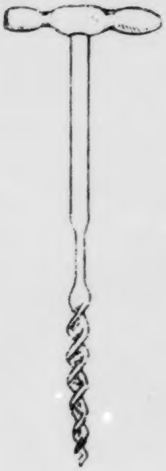
   b. Trowel

   a. Auger

   d. Probe

   c. Shovel

a



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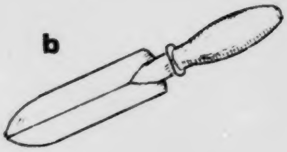

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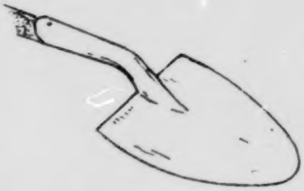

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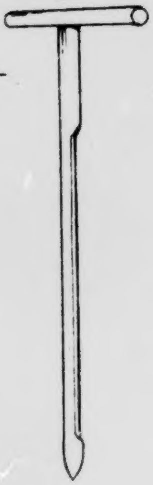


SAMPLE TEST QUESTION
Applying Soil Sample Test Results

TRUE (+) - FALSE (0)

+ 1. A soil with a pH of 7.5 is basic in reaction.

0 2. Nitrogen is one of the major elements tested for in agricultural soils.

0 3. A fertile soil is a productive soil.

+ 4. Nutrient balance is an important principle in soil fertility.

0 5. A soil with a pH of 7.0 is acid in reaction.

0 6. Acid soils are bad for all crops.

0 7. Fixed soil P is available for plant growth.

+ 8. You should learn all you can about a field before you walk that field to diagnose its problems.

+ 9. In problem fields, the problem area should be sampled separately from the rest of the field.

+ 10. Different soil types have different P and K supplying power.

COMPLETION

1. The development of a soil fertility program should begin with soil test.

2. Potassium is a major plant nutrient. The other two are nitrogen and potassium.

3. The most widely used fertilizer K source is muriate of potash.

4. Potassium sulfate contains 41 percent K_2O. (50 x .83 to convert K to K_2O).

5. The primary source of soil P is triple super on diammonium phosphate.

6. About 20-30 percent of applied P is available for the current crop.

7. To convert P to $P_2 O_5$, multiply by 2.2x9. (P_2O_5 to K x .49)

8. The most desirable pH range for farm crops is 6.0 to 7.0.

9. To increase the P_1 test one pound, you must must apply 9 pounds of P_2O_5 per acre.

10. To increase the K test one pound, you must apply 4 pounds of K_2O per acre.

UNIT J: SOIL SCIENCE AND CONSERVATION OF NATURAL RESOURCES

PROBLEM AREA: IDENTIFYING SOIL AMENDMENTS AND THEIR FUNCTIONS

SUGGESTIONS TO THE TEACHER:

This problem area should be taught to freshmen or beginning students enrolled in horticultural occupations or agricultural occupations programs. The recommended time for teaching this problem area is during the fall semester or prior to any planting. It is important that beginning students have a sound background in soils before they begin the growing of plants available to the horticulturalist. The estimated instructional time for this problem area is 3-5 days depending on how far the instructor wishes to go in developing identification skills at the beginning student level. If the teaching plan is limited to classroom discussion with little or no practice, the instructional time can be limited to 2 days or less. If the students are to be involved in outside activities the instructional time will need to be increased.

The instructor is encouraged to conduct a local search to locate other supplementary materials for use with this problem area. The items in this problem area are for reference and modification as instructors adapt this material to their local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-21-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in thse materials do not reflect, nor should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide, information sheet, student worksheets, and test questions were developed by Jim Ethridge. Transparency masters, and the transparency discussion guide were prepared by Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Metropolitan Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Soil science and conservation of natural resources

II. Problem area: Identifying soil amendments and their functions

III. Objectives: At the close of this problem area students will--

1. Define terms relating to plant growth media.
2. List the types of soil amendments.
3. Name the requirements of all media.
4. Name the characteristics of a good germination medium.
5. Identify various soil amendments, describe the material as to where it came from, its color, and what the material is used for.

IV. Suggested interest approaches:

1. Display four plants which have been grown in sand alone, heavy clay alone, top soil, and a soil mixture of 1/3 sand or perlite, 1/3 loam, and 1/3 peat moss. Allow the students to inspect and ask questions about the condition of the four plants.
2. Stimulate interest by asking the following questions: "Why did some plants grow better than others?" "Which kind of plants would you like to grow?" "What does one have to do to raise good plants?"
3. Display the various types of growing media and have students identify the functions of each.
4. Visit a nursery or greenhouse and observe and record their soil growing media.

V. Anticipated problems and concerns of students:

1. What are the types of media available and their functions?
2. What terms are used in describing soil media?
3. How do horticulture soils differ from field soils?
4. What are the common properties of a growing media?
5. What are the characteristics of a good growing media?

6. What are the different kinds of sands used in growing media?

7. What are the different kinds of perlite and vermiculite and when is each kind used?

8. What are some other soil amendments and when are they used?

VI. Suggested learning activites and experiences:

1. Have class read VAS Unit No. 5023 and record tentative answers to the problems and concerns identified by the class and instructor.

2. Display trays of materials used to make soils better for growing plants. At each tray place a label with some information. Have each student visit each sample and record the following information:

   a. Name of material.

   b. Describe material as to its origin, color, and other important items.

   c. What the material is used for.

3. List the important terms on the board and present a definition of each.

4. Discuss the characteristics of a good growth media.

5. Handout Worksheet 1 and have students complete it and turn it in for evaluation.

VII. Application procedure:

1. The main purpose of this unit is to familiarize the students with various growing media as to their characteristics and functions.

2. The students are also introduced to common terms and definitions associated with growing media.

VIII. Evaluation:

1. Worksheet 1.

2. Written Exercise on Soil Media.

3. Identification Exam on Soil Amendments.

IX. References and aids:

1. VAS Unit 5023. "Soils for Plant Growth-amendments for Container Soils."
2. Soil media with labels and information.
3. Tranparencies.
4. Tomato plants grown in various soil media.
5. Sample Test Questions.
6. Cooperative Extension Services--University of Illinois--Horticulture-Facts
    - a) #FL-5-79 "Physical Properties of a Good Container Soil Amendment"
    - b) #NC-1-79 "Using Hardwood Bark as a Growth Medium"
    - c) #FL-3-79 "Porogity in Soil Mixes"
    - d) #FL-4-79 "Container Soils are Different"
    - e) #VC-6-80 "Making Compost for the Garden"
    - f) #VC-5-80 "Organic Gardening and Soil Fertility
7. Greenhouse Soils by Dr. Paul E. Rieke and Dr. Darryl D. arncke, Lamotte Chemical Products Company Chestertown, Maryland 21620, 1975 Publication 36pp.

STUDENT WORKSHEET

COMPOSING SOIL OR ARTIFICIAL SOIL MIXES

I. Equipment and Materials Needed:

A. Sufficient number of open containers such as pots, cans, or saucers.

B. Samples of each of the common soil additives. The following are suggested: sphagnum peat, reed and sedge peat, sphagnum moss, muck, manure, ground corn cobs, straw, peanut hulls, wood chips, sawdust, perlite, vermiculite, calcined clay, silica (sharp) sand, beach sand, and cinders.

C. Labels for the samples.

II. Procedures:

A. The teacher will prepare all samples, discuss them and place them on display.

B. Students will observe the sample and note the characteristics of each as brought out in the discussion.

C. The labels will be replaced with numbers and the students will verify their ability to identify each material by completing the jobsheet.

III. Observations:

Sample Number	Name of Soil Additive	Characteristics of Soil Additive	Use of Soil Additive
1			
2			
3			
4			
5			
6			
7			
8			

Steps In Preparing Soil Mixtures:

1) Screen the soil to make it uniform and to eliminate large particles.
2) Moisten slightly extremely dry materials (especially peat).
3) Mix smaller quantities by putting the ingredients in a pile in layers, and turn the pile with a shovel until uniformity is attained.
4) Use a power driven cement mixer or shredder for large scale mixing operations.
5) Prepare the mixture at least one day in advance of use.

The Ideal Soil Mix Has These Characteristics:

1) Uniformity
2) Freedom From Disease
3) Low Soluble Salts
4) Good Drainage
5) Good Moisture Retention
6) No Shrinkage
7) Ease Of Preparation And Storage
8) Complete Availability
9) Light In Weight

TEACHER KEY

SAMPLE TEST QUESTIONS

1. Why are some loam soils not ideal for growing plants in containers?

   high soluble salts build up
   dry out too quickly
   shrinkage in the container
   compaction

2. Name four desirable characteristics of a germination medium.

   light weight, low in nutrients
   not costly
   holds desirable amounts of moisture
   sterilized

3. Name two requirements of all growing media.

   supports the plants
   provide nutrients to the plant
   provides water to the plant

4. Complete the chart on the following samples provide in the classroom.

	Name of Material	Comes From	Color	Make-up	Use
a.					
b.					
c.					
d.					
e.					
f.					
g.					

5. List five types of amendments

a. Vermiculite
b. Perlite
c. Sand
d. Peat
e. Spagnum

others: Soil
Manure
Shredded Bark
Wood Shaving
Saw Dust

6. Check the following characteristics which are considered to be desirable properties of mixing media:

x Sufficient firmness and density to hold cuttings or seeds in place.

x Fairly constant volume whether dry or wet.

x A pH level suitable for plant being grown.

___ Sufficient cloddiness so that the water will not drain off.

x Freedom of nematodes, seeds, weeds, and noxious disease organisms.

7. Match:

4 a. Aeration
3 b. Dolomite limestone
2 c. Perlite
8 d. Chelate of iron
7 e. Super-phosphate
1 f. Peat
6 g. Vermiculite
5 h. Media

(1) A kind of "soil" made up of partly decomposed plant life.
(2) A heat-treated material, like pumice, made of limestone.
(3) A fertilizer consisting of calcium magnesium carbonate.
(4) Exposure to air.
(5) Several things mixed together that act or serve as an intermediary.
(6) A mined micaceous mineral which expands when heated.
(7) Calcium hydrogen phosphate and calcium sulphate in powder form, to be mixed with fertilizer.
(8) A form in which iron can be readily available to plants, when applied to the soil or sprayed on the foliage.
(9)
(10)

8. Identify 5 advantages of incorporating organic matter and soil "lightening" material with loam soils.:

   a. Better aeration

   b. Greater ease of working

   c. Better drainage

   d. Better moisture-holding capacity

   e. Lighter in weight (easier to carry and cheaper to transport)

9. The ideals oil mix has these characteristics:

   a. Uniformity

   b. Freedom from disease

   c. Low soluble salts

   d. Good drainage

   e. Good moisture retention

   f. No shrinkage

   g. Ease of preparation and storage

   h. Complete availability

   i. Light in weight

10. The advantages of an artificial soil mix are:

   a. light in weight
   b. cheap, perhaps cheaper
   c. reproductable, can be remixed
   d. can be "tailored" to the crop

11. An ideal soil mix should be e (select one of the following responses):

   a. uniform
   b. low in soluble salt
   c. have good drainage
   d. be light in weight
   e. all of the above
   ab. choices a, b, and d only

12. Organic farming can best be characterized by which of the following? e .

   a. using organic materials
   b. not using pesticides and herbicides
   c. not resorting to the use of chemical additives such as fertilizer, pesticides or herbicides

d. using natural farming methods
e. choices a, b, and c

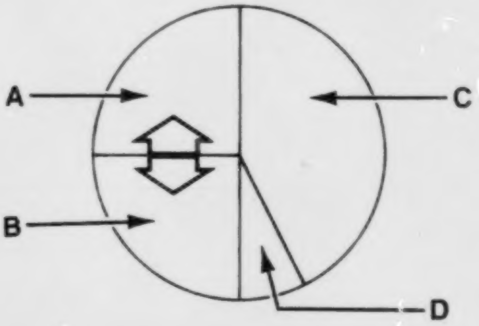
13. Match the material with its use(s).

___ sand
___ vermiculite
___ bark shavings
___ sphagnum peat

a. for body
b. for body and drainage
c. for water retention
d. for drainage
e. all the above

A. air
B. water
C. Inorganic material
D. organic material

FIELD SOIL



14. The amount of organic material in field soil is ___B___ .

a. 1%
b. 5%
c. 25%
d. 45%
e. 50%

15. Special materials added to the soil to help improve it are known as: ___D___

a) fertilizers
b) amendments
c) compost
d) all of these

16. Which amendment in this list is not organic? ___B___ .

a) peat moss
b) sand
c) sawdust
d) compost

17. A mixture of decomposing organic materials such as leaves, straw, and manure is known as: ___C___ .

a) peat moss
b) perlite
c) compost
d) vermiculite